2006 Ontario Building Code Overview Training Courses

Plumbing – All Buildings – 2007

Participant's Manual

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2006 Ontario Building Code Overview Training Courses

PLUMBING - ALL BUILDINGS - 2007

PARTICIPANT'S MANUAL

This course was developed by **Morrison Hershfield Limited**

for the **Ontario Ministry of Municipal Affairs and Housing.**

The course is based on the Ontario Building Code 2006 (O. Reg. 350/06), as amended.

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MODULE 1

INTRODUCTION

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INTRODUCTION

Welcome! Over the next few days, you will be concentrating on the principles of plumbing and the plumbing requirements of the Ontario Building Code, found mostly in Division B, Part 7.

The course has been designed to give you an understanding of the code requirements applicable to plumbing systems. Once you have completed this course you will be confident and comfortable with making decisions during the inspection process. This will help ensure the health and safety of your community.

RESOURCES

There are many resources that will assist you in this course, including:

- Your experience as an inspector
- The experience of others in the class
- The OBC and Building Code Act
- Exercises that ask you to understand why the regulations exist and to relate your experience to the information presented
- This workbook. This is your book, and you are encouraged to record answers and write notes in it. It will be a useful reference when you are back on the job.

The resources you will require for the class are this workbook and a 2006 Ontario Building Code (Volume 1 and 2). These documents are available from: www.publications.serviceontario.ca

The 2005 National Plumbing Code is optional for this course but may be of use in your regular work. This document is available from www.nrc-cnrc.gc.ca/virtualstore

A calculator, a highlighter and some sticky notes are recommended tools for helping you mark key tables and requirements.

MEET YOUR GROUP

Before you start into the course materials, it is important for you to meet the people you will be working with during this course. You have had a variety of experiences as an inspector, which you can share with the class; similarly, they have had experiences that they can share with you.

EXERCISE 1-1

Take a few minutes and introduce yourself to your group. Let them known where you're from, and what your background is. Listen carefully to the types of job experiences that other members of your group have had. They will be useful in completing exercises later on in this course.

NAME	**JOB TITLE**	**WORK RESPONSIBILITIES**

STOP

THE MUNICIPALITY/REGION

Plumbing inspection takes place in the context of the municipality or the region. The types of services offered by the municipality or region, such as water service and sewage disposal, have an impact on your role as a plumbing inspector.

The size of your municipality or region also affects your job. In smaller areas you may have to "wear many hats" - that is, you may be the building inspector as well as the plumbing inspector.

EXERCISE 1-2

Who, in your group, wears more than one hat (or role), and what are they? These people bring a different perspective to a plumbing inspection problem.

Name	"Hats"

STOP

ROLES OF THE PLUMBING INSPECTOR

Regardless of the other hats you may wear, you have a very important job as a plumbing inspector. Your role is to ensure the

health and safety of residents in your community by:

- Providing information - technical knowledge and information about the appropriate legislation - to contractors, the public and your Council.
- Examining the plumbing systems under your jurisdiction to ensure they comply with regulations.
- Applying, interpreting, administering and enforcing the requirements.
- Employing all your technical and personal skills to gain voluntary compliance with the Code.
- Co-operating with other building officials in the interests of the public.

Being an inspector calls for a combination of technical knowledge and an ability to deal with the public. Technical problems can usually be dealt with fairly easily; but dealing with the public requires tack and good judgement.

EXERCISE 1-3

JUDGEMENT

With your group, take a few minutes to discuss some of the problems you have had to deal with as a plumbing inspector that have required the exercise of judgement on your part.

STOP

YOUR OBJECTIVES FOR THIS COURSE

What do you expect to learn from this course?

EXERCISE 1-4

In your group, discuss this question and write your objectives on your group flip chart. After your group discussion, you'll be sharing these objectives with the rest of the class.

At the end of the course, you will assess how well these objectives have been achieved - so make sure you write them down.

STOP

FORMAL COURSE OBJECTIVES

This course has some specific objectives in mind. See how closely they match your own.

By the end of the course, you will be able to:

- Describe the theory of key plumbing systems
- Find Code requirements that govern plumbing
- Determine the requirements applicable to specific plumbing systems
- Identify deficiencies in plumbing design and installation
- Plan an inspection of plumbing installations
- Be familiar with plans of plumbing installations

COURSE FORMAT

Before you go on to accomplish these objectives, spend a few minutes acquainting yourself with the format of this course.

The course consists of eight modules, ranging in length from a couple of hours to more than a full day. Each module deals with a particular topic and builds on information presented in previous modules. This logical sequence makes it easier to remember what you've learned, as you progress.

Each module outlines the learning objectives of the module, and ends with a quiz so that you can see how well you are doing.

You have already encountered one type of exercise that will occur frequently throughout the course - the group discussion. This is probably the most valuable part of the course, as you share your knowledge and experience with your group and learn from them.

A variety of materials will be used to help you learn, such as actual pipe and fittings, overheads, diagrams and individual or group exercises.

THE FACILITATOR

An important person in this course is your facilitator. The facilitator is not here to lecture, but to guide your discussions, provide examples from experience, and mediate discussions.

Your facilitator is usually experienced in plumbing regulations and can offer valuable hints from years of experience. Don't expect the facilitator to have all the answers - no one does - but he or she can provide guidance for your search for the answers.

STOP

THE OBJECTIVE-BASED CODE

The 2006 Ontario Building Code is published in an "objective-based" format. The objective-based format adds to the technical requirements by identifying the underlying objectives and sub-objectives of those requirements. Each technical requirement that is an acceptable solution in Division B is linked to one or more objectives, as well as functional statements.

The objective-based format is intended to assist Code users in understanding technical requirements, why they exist and what they are intended to achieve. The objective-based code establishes a framework for evaluating "alternative solutions" against the performance achieved by "acceptable solutions" set out in the Code.

This course is updated to reflect technical changes to the 2006 Ontario Building Code. **Training related to the objective-based format, and how to deal with alternative solutions is part of another course.** This course addresses only "acceptable solutions".

A few key points about the objective-based code are below.

The organization of the 2006 Code is:

Division A	Compliance, Objectives and Functional Statements The new objectives and functional statements are in Division A. Definitions and the application of the Parts of the Code are here.
Division B	Acceptable Solutions This is where the technical requirements of the 1997 Code are located, with a similar Part structure.
Division C	Administrative Provisions This Division deals with permits, inspections and qualifications.

Remember that the full reference for Part 7 Plumbing is "Division B, Part 7 Plumbing". Always specify the appropriate Division if there is any chance of confusion. Where the Division is not referenced within this course, it is Division B.

When "OBC" is used in this course it refers to the Ontario Building Code, NOT the Objective Based Code.

STOP

A GUIDE TO THE USE OF THE OBC

The Ontario Building Code is a regulation made under the Building Code Act. The Code is essentially a set of minimum requirements governing the safety of buildings. It is not intended to be a textbook on plumbing design, advice on which should be sought from professional sources. Its primary purpose is the promotion of public safety through the application of appropriate uniform building standards.

The decimal numbering system of the previous Code is maintained within Divisions A, B and C of the 2006 Code. The first number indicates the Part of the Code, the second, the Section in the Part, the third, the Subsection and the fourth, the Article in the Subsection. An Article may be further broken down into Sentences (indicated by numbers in brackets), and the Sentence further divided into Clauses and Subclauses.

These are illustrated as follows:

7	Part
7.3.	Section
7.3.4.	Subsection
7.3.4.5.	Article
7.3.4.5.(5)	Sentence
7.3.4.5.(5)(a)	Clause
7.3.4.5.(5)(a)(i)	Subclause

Defined Words, Terms And Phrases

Words, terms and phrases with special meaning are defined in Division A, Sentence 1.4.1.2. of the OBC, and are shown within the body of the OBC in *italics*. The definition always applies unless the word, term or phrase has a special purpose definition listed elsewhere.

Non-Defined Words, Terms And Phrases

Consult Division A, Sentence 1.4.1.1. of the OBC. It provides direction for dealing with non-defined terms.
Note any questions, comment or concern in the space provided.

Abbreviations and Symbols and Referenced Documents

The OBC uses abbreviations and symbols throughout. Their meaning is found in Division A, Subsection 1.4.2.

For example, the abbreviation DWV means drain, waste and vent; and the expression '1 in 2' means a slope of 1 vertical unit to 2 horizontal units.

Abbreviations for organizations and associations (proper nouns) are found in Table 1.3.2.1. in Division B. For example, ASHRAE means American Society of Heating, Refrigerating and Air-Conditioning Engineers.

The table of all documents referenced in the OBC is found in Part 1 of Division B.

BASIC RULES FOR READING THE OBC

Scope And Application Of OBC Requirements

Individual requirements within the OBC do not apply to every *building*. Guidance in the application of each of the 12 Parts of Division B is found in Division A, Subsection 1.1.2.

For this course, it is important to know that Part 7 of Division B applies to all buildings.

Dealing With 'And'

The word '**and**' found at the end of the second last Clause of a Sentence with multiple Clauses means that the requirements of every Clause apply to the Sentence.

For example, Sentence 7.5.6.3.(1) reads:

> Except as provided in Sentences (2) and (3), a vent pipe that protects a fixture trap shall be located so that,
>
> (a) the developed length of the trap arm is not less than twice the size of the fixture drain,
>
> (b) the total fall of the trap arm is not greater than its inside diameter, and
>
> (c) the trap arm does not have a cumulative change in direction of more than 135 degrees.

Dealing With 'Or'

The word '**or**' found at the end of the second last Clause of a Sentence with multiple Clauses means that the requirement of the Sentence is satisfied by any Clause as applied individually.

For example, Sentence 7.5.3.1.(6) reads:

> Additional circuit vents shall be required,
>
> (a) when each cumulative horizontal change in direction of a branch served by a circuit vent exceeds 45 degrees between vent pipe connections, or

(b) where more than 8 circuit vented fixtures are connected to a branch between vent pipe connections.

Rules Of The OBC

The OBC is structured into a number of Rules that apply without exception.

For example, Sentence 7.5.7.2.(2) states:

> Every sanitary building drain shall terminate at its upstream end in a stack of at least 3 in. size.

General Rules Of The OBC And Exceptions

At other times, the user of the OBC has to consider a general rule and exceptions that may be applicable. Consider the requirements for the size of fixture outlet pipes given in Article 7.4.9.3.:

(1) Except as provided in Sentence (2) the size of every fixture outlet pipe shall conform to Table 7.4.9.3.

(2) The part of the fixture outlet pipe that is common to 3 compartments of a sink shall be one size larger than the largest fixture outlet pipe of the compartments that it serves.

When the OBC spells out a general rule and exceptions thereto, conformity with the OBC is obtained by complying with EITHER the general rule OR the exception.

Tables, Text And Footnotes

Whenever you are called upon to use a Table in the OBC, you have to consider the text associated with the Table and the footnotes.

For example, Table 7.4.10.8. forms part of Sentence 7.4.10.8.(1). Note (1) to Table 7.4.10.8. tells us that slope is the ratio of rise to run, in whatever measurement units are chosen.

Supplementary Standards And Referenced Documents

The **Supplementary Standards,** published as Volume 2 of the 2006 Building Code Compendium form an **integral part of the Ontario Building Code**.

The Supplementary Standards are referenced from within the OBC. For example, Sentence 7.4.10.4.(1) states that the maximum 15 min rainfall is to be determined in conformance with Supplementary Standard SB-1.

Appendices

The **Appendices to the Ontario Building Code**, published in Volume 2, **have been prepared for convenience only**. This material contains explanations that do not form part of the OBC and are not intended to limit the ways by which compliance with OBC requirements can be achieved.

STOP

ABBREVIATIONS

The following abbreviations are used in this course:

BCA	Building Code Act
CO	cleanout
DWV	drain waste vent
FD	floor drain
LAV	lavatory
OBC	Ontario Building Code
SS	soil stack
WC	water closet
WS	waste stack

ANSWER GUIDE

An answer guide is included at the end of this workbook.

During the class please do not look at the answer guide unless instructed by the facilitator.

If you are working on your own, you are encouraged to try each exercise and quiz yourself before turning to look at the answers.

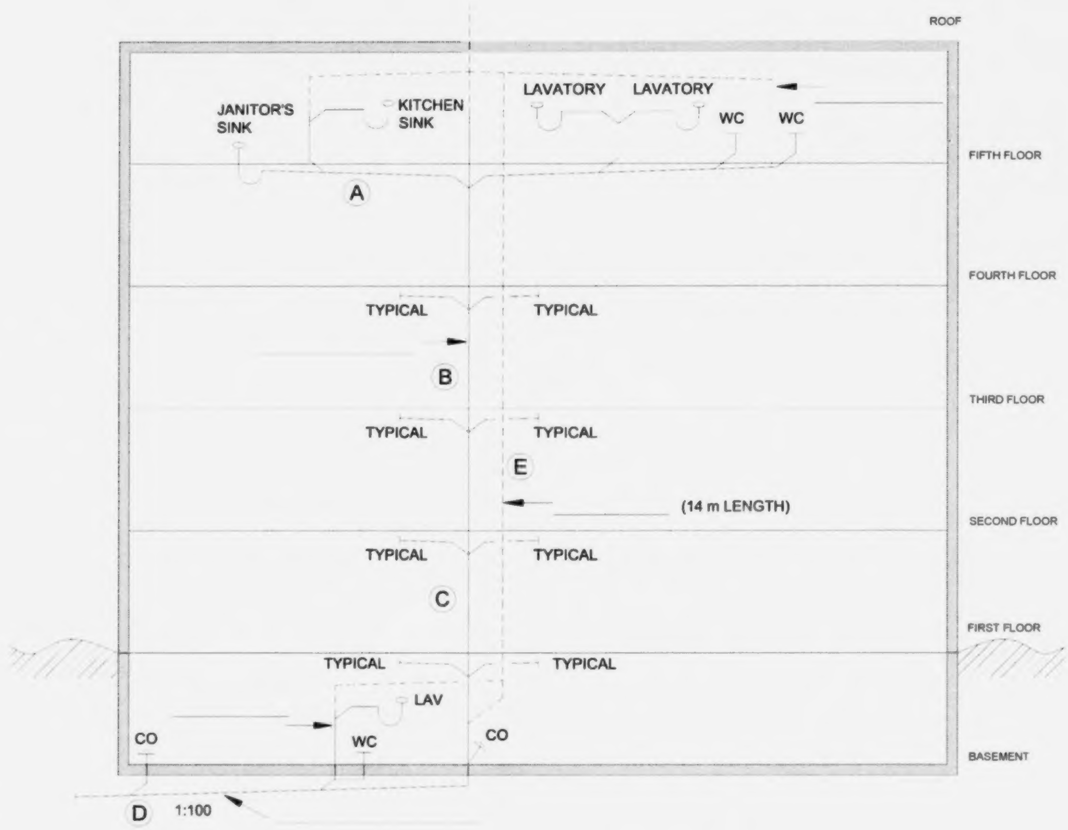
PRE-COURSE EXERCISE

Before you move on to the rest of this course, it will be useful to both you and the facilitator to assess how much you know about plumbing, plumbing regulations and plumbing inspections.

The pre-course exercise involves identifying and sizing drainage piping and vent piping. This will give you a benchmark to measure your knowledge level at the end of the course in this area.

Depending on your previous experience, you may not be familiar with the terms or the method for sizing the pipes. Do not worry if you are not able to do the exercise – by the end of the course you should have the knowledge to complete it!

Figure 1:1 Pre-Course Exercise


ROOF
JANITOR'S SINK
KITCHEN SINK
LAVATORY
LAVATORY
WC
WC
FIFTH FLOOR
A
FOURTH FLOOR
TYPICAL
TYPICAL
B
THIRD FLOOR
TYPICAL
TYPICAL
E
(14 m LENGTH)
SECOND FLOOR
TYPICAL
TYPICAL
C
FIRST FLOOR
TYPICAL
TYPICAL
LAV
CO
WC
CO
BASEMENT
D
1:100

NOTES:
JANITOR'S SINK - 2 IN. TRAP
LAVATORIES - 1 1/4 IN. TRAP
WC - TANK TYPE
CO - CLEANOUT

Notes:

Notes:

Pipe Sizing Table

	Pipe Type	Hydraulic Load Served (fixture units)	Size (in.)	Code Reference
A				
B				
C				
D				
E				

END OF MODULE

MODULE 2

DRAINAGE

PLUMBING – ALL BUILDINGS - 2007

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LEARNING OBJECTIVES

Upon completion of this module, participants will be able to:

- Define drainage terms
- Calculate fixture units and hydraulic loads
- Size horizontal and vertical sanitary drainage piping
- Identify code requirements for locations of clean outs and manholes
- Identify the code requirements for storm and sanitary piping, direct and indirect connections, pump discharge and laundry facilities
- Determine compliance and non-compliance of the installation with the submitted plans examination

INTRODUCTION

Every successful plumbing system design begins with identification of needs. The owner, architect, professional engineer, or the designer must indicate:

- The required number of fixtures for washrooms and kitchens,
- The fixtures in other areas such as laundry rooms or service rooms
- The water supplies and drainage facilities needed in each of these areas

In addition, water supply and drainage will be needed for:

- Food preparation areas
- Manufacturing process areas
- Special uses in schools and hospitals
- etc.

In this module we will be focusing on drainage piping.

DRAINAGE TERMS

As an inspector you will be called upon to inspect drainage piping and to verify that it is correctly sized. Before you can verify compliance for pipe sizes, it is important to know the terminology used in plumbing. The Ontario Building Code devotes a section on definitions and although this may be a review to some, it is important to clearly understand some basic terms. As an inspector you should easily be able to recognize a part of the plumbing system and understand its relationship to the complete system.

The sanitary system consists of two systems: the drainage system (drainage piping) and vent system (vent piping). In this module we will be covering drainage systems, the venting system will be covered in future modules. The drainage system is often referred to as drainage piping which is the part of the sanitary system that transports water-borne waste from the fixture to the place of disposal.

Some of the more commonly used terms that are fairly important and are defined in Division A Part 1 of the Code, are:

Sanitary Unit

Soil Pipe

Waste Pipe

Nominally Horizontal

Nominally Vertical

Fixture Outlet Pipe

Fixture Unit

Waste Stack

Horizontal Branch

Building Drain

Building Sewer

Clear Water Waste

Fixture Drain

Soil Stack

Trap Arm

Sanitary Building Drain

EXERCISE 2-1

Take 15 minutes and review the definitions of the above terms. The facilitator will assign each group certain terms to write on a flipchart and present to the class.

STOP

EXERCISE 2-2

Refer to Figure 2a and list the correct term for the parts of the underground drainage system.

NOTE: The stacks receive discharge from the following fixtures:

Stack A: 2 - flush tank Water Closets (W.C.)
2 - bathtubs
2 – lavatories

Stack B: 2 - flush tank W.C.s
2 - lavatories
2 - shower stalls

Stack C : 1 - service sinks
2 - 2 compartment kitchen sinks

Stack D : 2 - flush tank W.C.s
2 – lavatories

Stack A ____________________

Stack B ____________________

Stack C ____________________

Stack D ____________________

Point 1 ____________________

Point 2 ____________________

Point 3 ____________________

Point 4 ____________________

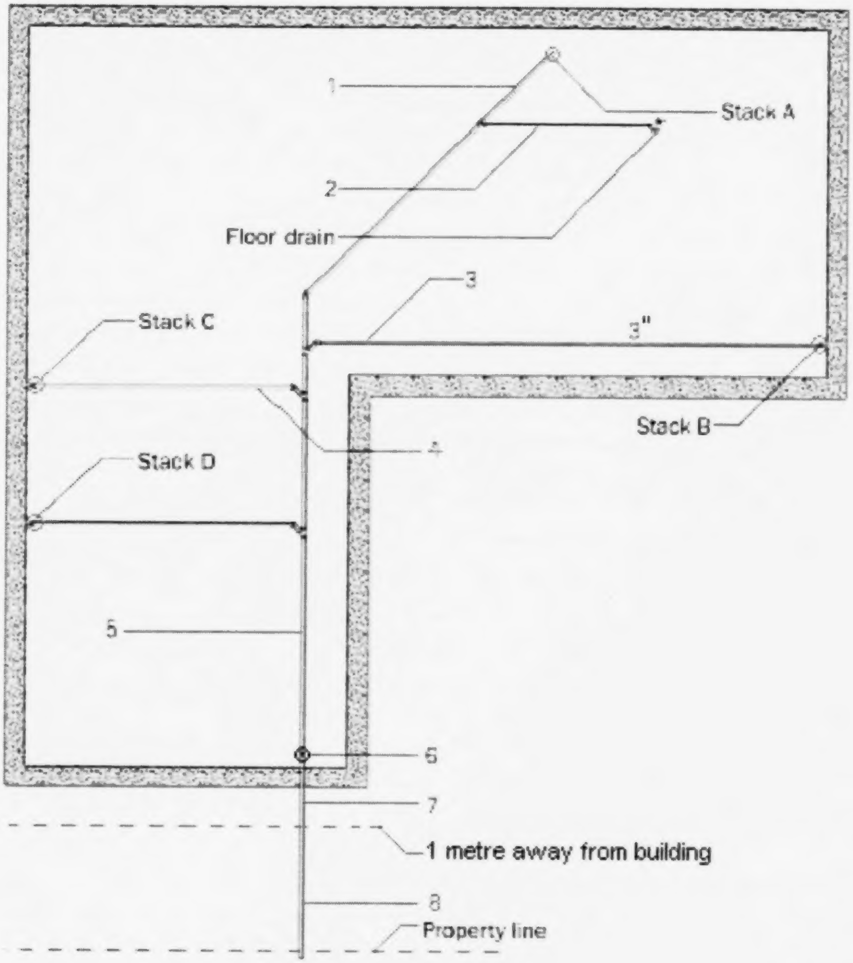
Point 5 ____________________

Point 6 ____________________

Point 7 ____________________

Point 8 ____________________

Figure 2:1 Underground Drainage System


1
Stack A
2
Floor drain
3
Stack C
3"
4
Stack B
Stack D
5
6
7
1 metre away from building
8
Property line

STOP

FIXTURE UNITS AND FLOW RATES

Take 10 minutes to read the following pages and complete Exercise 2-3.

Before technology changed in the plumbing industry, it was common practice to install drainage piping larger than what is required. It was thought that the larger the piping the more efficient the drainage would be. The problem was, as liquids would drain, the oversized pipe would only have a shallow depth of sanitary sewage. This depth of sewage was not enough to carry solid matter. It was later proven that, when flowing with discharge, if the horizontal drainage pipe was filled between one-third and one-half of the diameter, it would create a scouring action, keeping the drain clear.

Once the efficient flow was determined, the next step was to establish a relationship between the discharge loads of the various plumbing fixtures and each pipe size. A unit of measure was established which would serve to:

1) **Compare the discharge load** of one fixture with that of another, and

2) **Establish a load capacity** for each size of pipe in both the horizontal and vertical position.

This unit of measure later became known as the "fixture unit".

The next task was to establish a base for the unit system. In other words, "What was one fixture unit to represent?" Various fixtures were tested, it was found that the volume rate of fixtures with 1 ¼ inch outlets, such as a lavatory, was about 6.25 imperial gallons per minute. It was then decided to term the discharge from this type of fixture "one fixture unit", although time and frequency of use also plays into establishing the number of fixture units.

The test results of all fixtures were recorded and studied. Each fixture was then assigned a fixture unit value or load factor according to the ratio of its performance compared to that of fixtures with 1 ¼ inch outlets. Here are some of the load factors:

a) Lavatory (1 ¼ inch outlet) - 1 fixture unit

b) Shower (1 ½ inch outlet) - 1 ½ fixture units

c) Water Closet with Flush Tank (3 inch outlet) - 4 fixture units

Table 7.4.9.3. shows the hydraulic load for most fixtures you will commonly find in a building.

If a fixture is not listed in this table, the hydraulic load is determined by the size of the trap according to Table 7.4.10.2.

Some fixtures, such as pumps or air conditioning fixtures, may produce a continuous or semi-continuous flow into the drainage system. In order to consider this load on the drainage system, Article 7.4.10.3. states how to convert the flows to fixture units. Continuous flows are converted by multiplying the flow (in litres per second) by 31.7 to get fixture units. Semi-continuous flows are converted by using Table 7.4.10.3.

EXERCISE 2-3

Using Tables 7.4.9.3., Table 7.4.10.2., Article 7.4.10.3., and Table 7.4.10.3. to determine the fixture units for the following fixtures, trap sizes and flows.

1) Domestic clothes washer ____________________

2) 3 compartment Laundry tray ____________________

3) Potato Peeler ____________________

4) Flush tank water closet ____________________

5) Siphon jet urinal ____________________

6) Shower drain for six heads ____________________

7) Commercial garbage grinder ____________________

8) Commercial dishwasher ____________________

9) 2 in. trap ______________________________

10) 3 in. trap ______________________________

11) Continuous flow of 0.09 litres per second from an air conditioner

____

____

Code Ref:____________________________________

12) Semi-continuous flow of 0.1 litres per second

____

____

Code Ref:____________________________________

STOP
HYDRAULIC LOADS

Tests were also performed on horizontal and vertical piping to determine the maximum volume rate of liquid that could be discharged without causing severe changes of atmospheric pressure within the system. The volume rate for each pipe size was then converted to fixture units and was termed the "maximum hydraulic load" for that pipe.

For example, the following maximum hydraulic loads were determined:

a) 1½ inch Horizontal Pipe - 4 fixture units
b) 1½ inch Vertical Pipe - 8 fixture units

EXERCISE 2-4

Turn to Tables 7.4.10.7. and 7.4.10.6.B and state the maximum hydraulic load for the following.

Horizontal Branch Table: ____________________

1) 1¼ inch

2) 1½ inch

3) 2 inch

Vertical Stack Table: ____________________

4) 1¼ inch

5) 1½ inch

6) 2 inch, serving a 4 storey building

STOP

SIZING THE SANITARY DRAINAGE PIPING

The OBC includes tables in Subsection 7.4.10. that show the maximum hydraulic loads horizontal and vertical drainage pipes can carry. It is important that you are able to interpret these tables in order to calculate pipe sizes and verify pipe sizes.

Four tables in Subsection 7.4.10. show the maximum hydraulic loads for horizontal and vertical sanitary drainage pipes. Two tables deal with pipes that are less than 3 inches in size. For horizontal sanitary drainage pipes that are 3 inches or larger, the slope of the pipe must be known.

Review Subsection 7.4.10 and complete Exercise 2-5.

EXERCISE 2-5

Fill in the table on the next page as a summary of the OBC sizing tables for sanitary drainage piping. List the information that is needed to size the pipe.

OBC Tables for Sizing Sanitary Drainage Piping

Table	Type of Pipe Table Applies To	Information Required to Use Table
7.4.10.6.A.		
7.4.10.6.B.		
7.4.10.8.		
7.4.10.7.		

STOP

EXERCISE 2-6

Take 15 minutes to read Subsections 7.4.9 and 7.4.10 and then answer the following questions.

1. List the four restrictions to be kept in mind when sizing drainage piping serving water closets.

Code Ref:

Code Ref:

Code Ref:

Code Ref:

2. State the maximum percentage loading for vertical and horizontal drainage piping.

Code Ref:

STOP

SIZING PROCEDURE

To determine the size of drainage pipes, follow these steps:

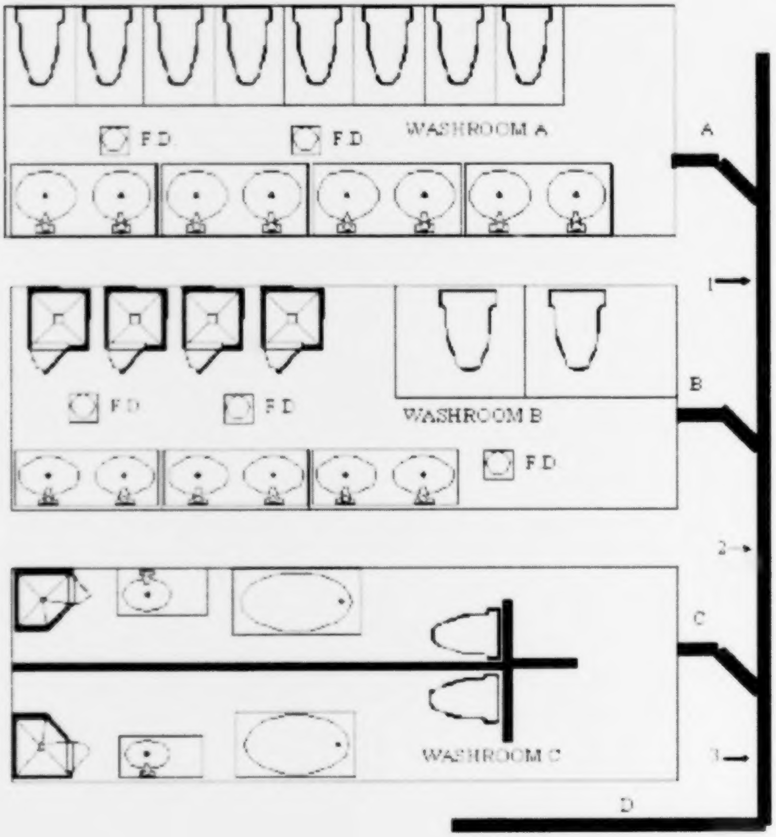
1. Determine the **hydraulic load** (in fixture units) for each fixture in the system using Table 7.4.9.3.
2. Determine the **cumulative hydraulic load** (in fixture units) for each pipe section.
3. Determine the **pipe size for the soil or waste stack** using Table 7.4.10.6.A.
4. Determine the pipe size for the **horizontal sanitary drainage pipes**. Use Table 7.4.10.7. for pipes less than 3 in., and use Table 7.4.10.8. for pipes 3 in. and larger.

Note: Steps 3 and 4 may be reversed, depending on the configuration of drainage pipes.

EXERCISE 2-7

Refer to the Figure 2b and calculate the size of horizontal branches A, B, C, and D, and stack sections 1, 2, and 3. Note that the figure is an elevation drawing with the vertical stack on the right side, but the washrooms are in plan view to illustrate the fixtures.

Figure 2:2 Sizing Branches and Stacks


F D
F D
WASHROOM A
A
1
F D
F D
WASHROOM B
B
F D
2
C
WASHROOM C
3
D

Note: Pipes are installed with the minimum slopes required by the OBC.

1. Calculate Total Hydraulic Loads and the Cumulative Hydraulic Loads

Washroom A:

8 - 1¼" lavatories - fixture units
8 direct flush valve w/c - fixture units
2 - 3" floor drain - fixture units
Total Hydraulic Load fixture units

Washroom B:

2 direct flush w/c - fixture units
6 - 1¼" lavatories - fixture units
4 - shower stalls - fixture units
3 - 3" floor drains - fixture units
Total Hydraulic Load fixture units

Washroom C:

2 - 1¼" lavatories - fixture units
2 bathtubs - fixture units
2 flush tank water closet - fixture units
2 shower stalls - fixture units
Total Hydraulic Load fixture units

2) What is the minimum slope of the horizontal drainage pipes?

____

Code Ref: __________________

3) Determine Size of Branches

Branch A:
Reason:
Code Ref:

Branch B:
Reason:
Code Ref:

Branch C:
Reason:
Code Ref:

Branch D:
Reason:
Code Ref:

4) Determine Size of Stack Sections

Section 1:
Size:
Code Ref:

Section 2:
Size:
Code Ref:

Section 3:
Size:
Code Ref:

STOP

CLEANOUTS AND MANHOLE REQUIREMENTS

A **cleanout** means a fitting access in a drainage system or venting system that is installed to provide access for cleaning and inspection and that is provided with a readily replaceable airtight cover.

A **manhole** is not a defined term but it means an opening with a lid that allows access to a sewer.

The purpose of a cleanout is to allow the insertion of cleaning equipment into the drainage piping to remove any blockage or obstructions. Manholes allow access for cleaning and inspection of larger sewers.

Background Information on Blockages

A blocked drainage pipe often becomes a costly and destructive problem for building owners to repair. Partially blocked pipes result in the slow draining of fixtures and inefficient operation of water closets, while totally blocked pipes cause sewage back-up through floor drains or fixtures, often causing property damage and a potential health hazard.

Blockages in drainage piping are generally caused by one or more of the following conditions:

1. Improper Sizing

   a) Over sizing: the drain tends to clog because the flow is too shallow to "float" the solids to the public sewer.

   b) Under sizing: the flow becomes "sluggish" because the pipe is too full. The solids tend to pile up and the drain may become blocked throughout its entire length.

2. Improper Grading

   a) Too Much Grade: the water is moving at a high velocity, leaving the solids behind. The solids then tend to pile up at the slightest obstruction. Too much grade also creates wear on the pipe walls due to increased speed of the effluent through the pipe.

   b) Too Little Grade: this also causes a sluggish flow, allowing the solids to pile up along the entire pipe run. This fault often results in the complete blockage of a horizontal drain.

It is important to note (for diagnostic reasons) that undersizing and too little grade give rise to the same result which is complete blockage of the pipe, while oversizing and too much grade tend to have solids deposited in certain areas.

3. Poor Workmanship

A poorly constructed joint or connection is often a factor in creating a blockage, and the blockage will likely reoccur regularly at the same point. The only way to remedy this situation is to repair or completely reconstruct the joint, an expensive procedure when it is located below ground or in a wall.

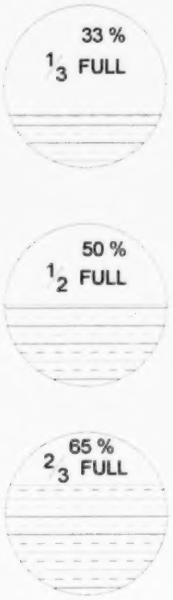
4. Misuse

Although the plumber has limited control over this problem, whenever possible, an attempt to educate the building owner as to some "do's" and "don'ts" of using the plumbing system may be of some help.

Don't allow toys, rags, diapers or other insoluble objects to be flushed down water closets.

The figure below shows the optimum loading of a horizontal drainage pipe.

Figure 2:3 Optimal Loading of Horizontal Drainage Pipe



- very little scouring action
- solids have a tendency to adhere to pipe wall
- lack of water leaves solids behind

- scouring action
- provides adequate air above liquid

- full scouring action to clean pipe
- adequate air space above liquid
- maximum water occupied area permitted

EXERCISE 2-8

Take 10 minutes to read subsection 7.4.7. When you are finished complete the following questions. Class discussion will start in 30 minutes.

1. List the minimum size and maximum distance between clean outs for the following:

a) 4" building drain
Min. Size:
Max. Distance:
Code Reference:

b) 2" horizontal sink waste pipe
Min. Size:
Max. Distance:
Code Reference:

c) 5" building sewer
Min. Size:
Max. Distance:
Code Reference:

d) 10" storm building drain
Min. Size:
Max. Distance:
Code Reference:

e) 6" horizontal branch
Min. Size:
Max. Distance:
Code Reference:

2. State the minimum size requirements for clean outs.
   a)
   b)
   Code Ref:

3. Give three examples of how a blockage in a drainage pipe may occur. Explain the reason why for each.
   1)

   Code Ref:

   2)

   Code Ref:

   3)

   Code Ref:

4. Describe when a manhole is required on a building sewer and state the maximum distance between the building and the first manhole to which the building sewer connects.

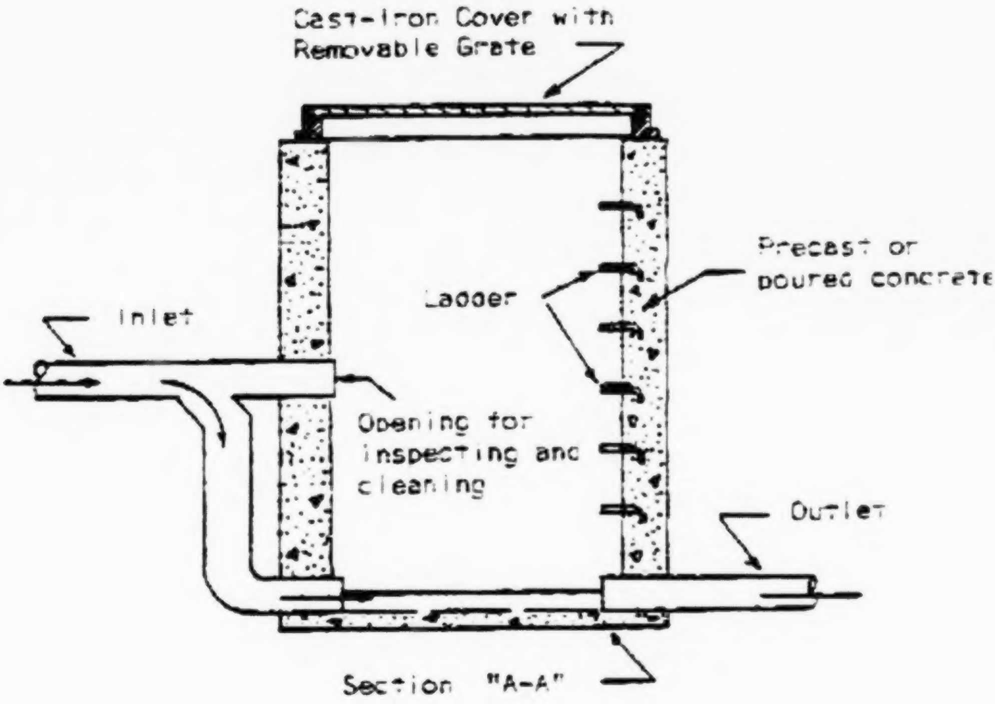
Code Ref:

STOP

CONSTRUCTION OF A MANHOLE

Figure 2:4 illustrates a manhole that is typical construction when it is necessary to change the elevation of a sewer or where there is a junction of two or more sewers that are at different elevations. This figure is provided for reference and interest only.

Figure 2:4 Building Sewer Manhole


Cast-Iron Cover with Removable Grate
Precast or poured concrete
Ladder
Inlet
Opening for inspecting and cleaning
Outlet
Section "A-A"

EXERCISE 2-10

Read Article 7.4.7.3. and Article 7.5.7.6. describe how a manhole is to be designed.

(1)

(2)

(3)

(4)

(5)

STOP

PRIVATE SEWER REQUIREMENTS

Private sewers are not directly regulated by the OBC. Sentence 7.1.5.5.(1) states that private sewers shall be installed according to the following MOE (Ministry of the Environment) publications:

- Guidelines for the Design of Sanitary Sewage Systems
- Guidelines for the Design of Storm Sewer Systems

A private sewer is defined in Division A,, Article 1.4.1.2., and the definition includes a description of what it is and what it is not. Take a moment to review the definition.

You will typically find a private sewer serving multiple buildings on private property, such as a condominium complex, a resort, or a school campus. Key features of private sewers are that they are not owned or operated by a municipality, and they receive waste (sanitary or storm) from more than one building.

Not all privately-owned sewers are private sewers that are governed by the MOE guidelines. For example, according to the definition, a private sewer does NOT include:

- A sewer serving two semi-detached dwelling units,
- A sewer that serves both a main building and an ancillary building for industrial, commercial or care occupancies, or
- A sewer that serves 5 or fewer units in a row housing complex.

PROTECTION FROM BACKFLOW

Article 7.4.6.4. deals with the installation of backwater valves. Backwater valves are intended to protect against backflow or surcharge in a sewer system. However, they can also lead to blockages if not properly installed or maintained.

Sentence 7.4.6.4.(1) prohibits the installation of a backwater valve on a building drain. However, the next sentence permits a backwater valve subject to certain conditions. Take a moment to review these conditions.

EXERCISE 2-11

Take 15 minutes to read the following articles. These articles deal with different aspects of storm and sanitary drainage systems. After you read the articles, write their titles in the space provided, and answer the questions below.

Article	Title
7.1.5.2.	
7.1.5.4.	
7.1.5.5.	
7.3.5.7.	
7.4.5.2.	
7.4.5.3.	
7.4.6.1.	
7.4.9.4.	

1. Explain when and why a trap would be required on a storm drainage system.

Code Ref:

2. Explain how and when subsoil drainage piping may be connected to a sanitary drainage system.

Code Ref:

3. Describe how a building drain or a building sewer shall be installed when buried closer than 2.44 metres (8 feet) to a water service pipe.

Code Ref:

4. What does piping have to be protected from based on Articles 7.3.5.1. to 7.3.5.6.?

5. When is a backwater valve permitted to be installed on a building drain?

Code Ref:

STOP

DIRECT AND INDIRECT CONNECTIONS

In some plumbing applications there will be a need for indirect connections between a fixture and the drainage system.

Indirect connections are used when it is important that the contents within the fixture or the fixture itself be protected from possible contaminants from possible backflow in the drainage line. An indirect connection provides this protection with an air break.

Some examples of indirect connections are:

- HVAC connections (condensate line and relief valve discharge)
- Water softeners
- Restaurant equipment such as steam tables, ice making machines, food preparation areas
- Bar sinks storing ice or fruit
- Hospital equipment such as sterilizers

Read the definition of "indirectly connected" and "directly connected" in your code and discuss where you will normally find indirect connections.

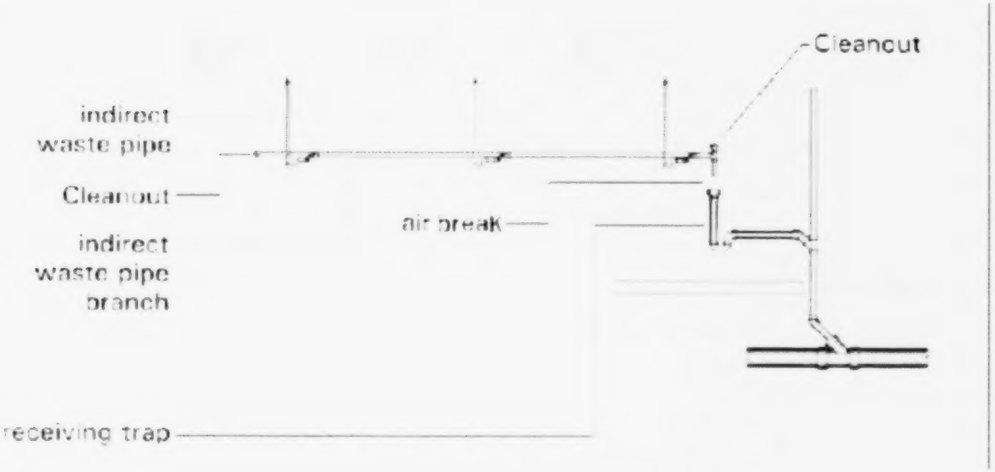
Article 7.4.2.1. has a general rule that all fixtures be directly connected to a sanitary drainage system, however there are some exceptions where the fixtures may be indirectly connected to a sanitary drainage system.

However, there is a list of specific devices that are required to be indirectly connected to a drainage system. Article 7.4.2.3. describes how groups of these fixtures can be directly connected to each other, and how the indirect connection can be made downstream, subject to conditions.

It is important to note that waste pipes carrying waste from any device for the display, storage, preparation or processing of food or drink shall be trapped.

The figure below illustrates how an indirect connection shall be installed.

Figure 2:5 Indirect Connection


Cleanout
indirect waste pipe
Cleanout
air break
indirect waste pipe branch
receiving trap

Article 7.3.3.11. specifies that the fixture drain of an indirect connection must terminate above the flood level rim of a directly connected fixture and must be separated by a minimum air break of 25 mm.

EXERCISE 2-12: Indirect Connections

Read Articles 7.3.3.11, 7.4.2.1, 7.4.2.3, and 7.4.3.2. Complete the following questions. Class discussion begins in 15 minutes.

1) Describe how an indirect connection shall be installed.

____

____

____

Code Ref: ______________________________________

2) What are the restrictions for location of indirect connections? What would be the reason for these restrictions?

____

____

Code Ref: ______________________________________

3) List the devices that shall be indirectly connected to a drainage system. With your group give one or two examples for each item and the type of occupancy in which you might find the indirect connection.

Code Ref:

4) Can more than one fixture outlet pipe serving a fixture listed in Clause 7.4.2.1(1)(d) be directly connected to a branch? If so, describe how.

Code Ref:

5) What is the minimum size of air break required for indirect connections?

____

____

Code Ref:_________________________________

6) What are the two methods of protecting a floor drain in a walk-in cooler from sewer surcharge ?

____

____

Code Ref:_________________________________

STOP

PUMP DISCHARGE

Only sanitary drainage piping that is lower than the elevation of the sanitary building sewer is permitted to connect into a sewage tank, and the sewage tank must be equipped with a sewage ejector. When the liquid waste in the tank reaches a certain depth, the sewage ejector pumps the waste to a drain that will allow gravity drainage to a place of disposal or a public sanitary sewer.

In addition, such a tank must be airtight except for a vent and equipped with a union, a check valve and a shut-off valve installed in that order, downstream from the tank on the discharge pipe as per Article 7.4.6.3.

A sewage ejector connection is downstream of the building trap because the velocity and pressure created by the pump may cause problems with the building trap.

STOP

TESTING

EXERCISE 2-13

Subsection 7.3.6 states which tests may be done on the drainage and venting system. Read through this Subsection; spend five minutes discussing the following questions with your group. Use your flipchart.

1. Which of the four tests outlined in this Subsection are suitable during inspection of drainage and venting system?

   Code Ref:

2. Which tests must be done at the wastes and stacks inspection?

   Code Ref:

3. When would you recommend an air test?

   Code Ref:

4. Where would you use a ball test?

   Code Ref:

5. How are final tests performed?

   Code Ref:

EXERCISE 2-14

Examine the following drawings and indicate the drain sizes in the circles (A-D). Do not size the vent pipes (dashed lines), as this will be done in the next module.

Assume the following:

L = Lavatory with 1¼" outlet

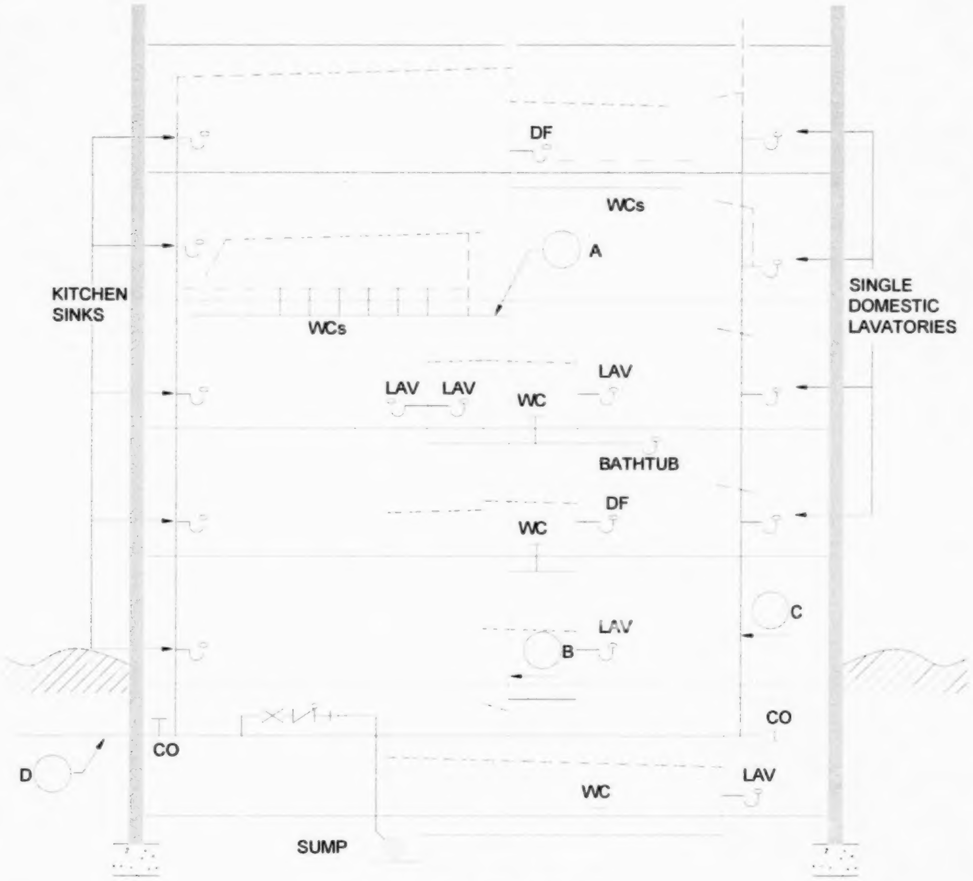
WC = direct flush water closet

Sump pump has a semi-continuous flow of 0.2 L/s

Building drain slope @ 1:100

Branch vents slope towards the drains

Figure 2:6 Sizing Exercise


DF
WCs
A
KITCHEN SINKS
SINGLE DOMESTIC LAVATORIES
WCs
LAV
LAV
LAV
WC
BATHTUB
DF
WC
C
LAV
B
CO
CO
D
LAV
WC
SUMP

NOTE: FITTINGS NOT SHOWN

STORM DRAINAGE SYSTEMS

A storm drain system carries water that is discharged from a surface as a result of a rainfall, snowmelt or snowfall. The water from roofs and paved surfaces is carried by a leader to a storm building drain, sewer or other place of disposal. The hydraulic load from roofs and paved surfaces is required to determine the size of the horizontal storm drain and storm sewer.

Hydraulic Loads for Storm Drainage

Roof drainage systems are designed to carry off the rainwater from the most intense rainfall that is likely to occur. A certain amount of time is required for the rainwater to flow across or down the roof before it enters the gutter or drainage system. This smoothes out of the most rapid changes in rainfall intensity. The drainage system, therefore, need cope only with the flow of rainwater produced by the average rainfall intensity over a period of a few minutes.

In Canada it has been customary to use the 15 minute rainfall that will probably be exceeded on an average of once in 10 years. This information can be found in the Supplementary Standard SB-1 that contains climatic data for locations in Ontario.

The hydraulic load from a roof or a paved surface is calculated as described in Sentence 7.4.10.4.(1). Take a moment to read this sentence now.

The hydraulic load calculation is:

$$\text{Hydraulic Load (L)} = \text{15 minute rainfall (mm)} \times \left[\text{area of surface drained } (\text{m}^2) + \frac{1}{2}\ \text{area of largest adjoining vertical space } (\text{m}^2) \right]$$

Note: The hydraulic load is a measurement of volume in litres (L). The right side of the equation is also a volume expressed in square metres times millimetres. The equation does not need additional factors because
1000 litres = 1 cubic metre.

The 15 minute rainfall can be found in Supplementary Standard SB-1 Table 1.2, Column 7.

The surface drained is the horizontal projection of roof or surface served by the leader or drain.

The largest adjacent vertical surface is typically the wall of a higher storey if there is one.

A hydraulic load may need to be calculated for fixtures that produce continuous or semi-continuous flow. An example is flow from a sump pump or weeping tile system permitted to drain to the storm drainage system. Sentence 7.4.10.3.(2) requires the hydraulic load be calculated as 900 litres for each litre per second of flow.

Rain Leader Sizing

The hydraulic load from the surface drained in litres determines the size of the rain leader. Use Table 7.4.10.10. to size a circular rain leader. For sizing non-circular rain water leaders consult Table 7.4.10.11. in the National Plumbing Code.

To prevent an increase in pipe size for short horizontal offsets of rain leaders, Sentence 7.4.10.10.(1) permits no change in pipe size provided the rain leader is:

- Located immediately under a roof
- Is not more than 6 m long
- Has a slope not less than 1 in 50

If the offset is more than 6m long, it needs to be sized as per Table 7.4.10.9.

Horizontal Storm and Drain and Sewer Sizing

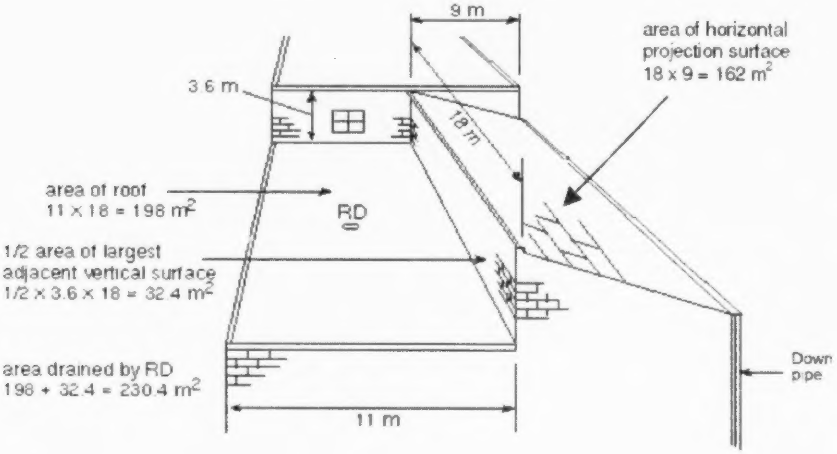
Once you have determined the hydraulic load from the roof or surface, use Table 7.4.10.9. to determine the size of horizontal storm drain pipe or storm sewer. The table is based on the hydraulic load and slope of the pipe. The minimum size of a horizontal storm and sewer drain is 4 inch per Sentence 7.4.9.4.(2).

STOP

EXAMPLE – SIZING STORM DRAINAGE PIPING

Calculate the size of the rain leaders, the horizontal storm drain and the storm sewer for the building shown in Figure 2:7. The building is in Bancroft, Ontario. The slope of horizontal pipes is 1 in 100.

Figure 2:7 Example of Sizing Storm Drainage Pipes


9 m
area of horizontal projection surface
18 x 9 = 162 m²
3.6 m
18 m
area of roof
11 × 18 = 198 m²
RD
1/2 area of largest adjacent vertical surface
1/2 × 3.6 × 18 = 32.4 m²
area drained by RD
198 + 32.4 = 230.4 m²
Down pipe
11 m

The hydraulic load needs to be calculated for two roof surfaces - the flat roof and the sloped roof and the leaders that serve them.

Step 1: Calculate surface area drained.

Flat Roof: 11 m x 18 m = 198 m^2

Largest adjacent vertical surface to flat roof:
= (1/2 x 3.6 m x 18 m) = 32.4 m^2

Total area drained by roof drain on the flat roof = 230.4 m^2

Use the horizontal projection for the sloped roof:
Sloped Roof: 18 m x 9 m = 162 m^2

Ignore the small vertical wall next to the sloped roof.

Step 2: Find the local rainfall intensity (15 minute rainfall).

The building is located in Bancroft. From Table 1.2 in SB-1, Column 7:

15 min Rainfall = 25 mm

Step 3: Determine the hydraulic load.

Flat Roof = 25 mm x 230.4 m^2 = 5 760 L

Sloped Roof = 25 mm x 162 m^2 = 4 050 L

Step 4: Determine the size of the rain leaders.

Use Table 7.4.10.10.

Flat Roof Rain Leader: A 4 inch circular rain leader will serve a hydraulic load of 5 760 L.

Sloped Roof Rain Leader: A 3 inch circular rain leader will serve a hydraulic load of 4 050 L.

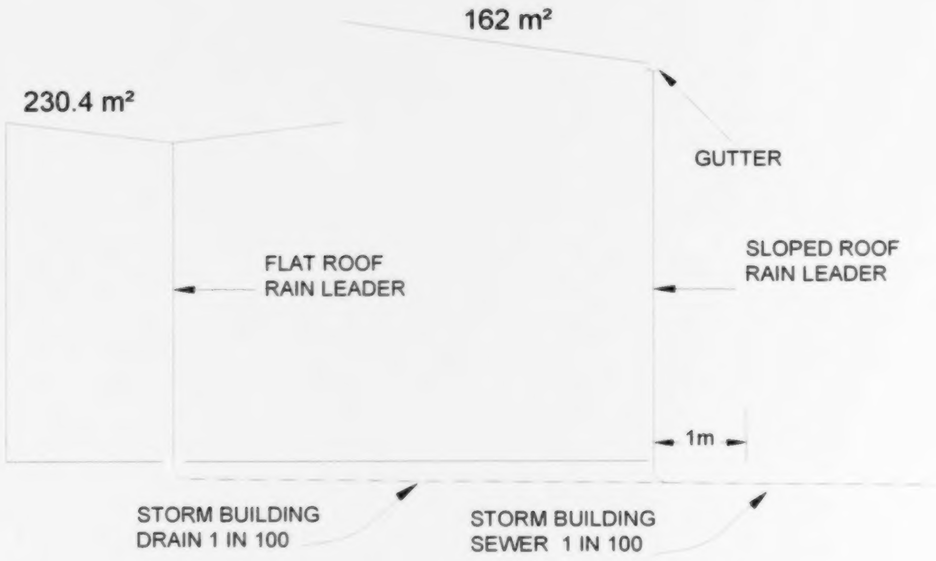
Step 5: Determine the horizontal storm drain size.

The horizontal storm drain carries the hydraulic load from the flat roof of 5 760 L. Column 5 applies in Table 7.4.10.9. for a pipe at a slope of 1 in 100. The horizontal storm drain is required to be 5 inches.

Step 6: Determine the horizontal storm sewer size.

The total hydraulic load is from both the flat roof and sloped roof:
5 760 L+ 4 050 L = 9 810 L. With a slope of 1 in 100, the sewer is required to be 6 inches.

Figure 2:8 Example of Sizing Storm Drainage Pipes (Elevation View)


162 m²
230.4 m²
GUTTER
FLAT ROOF
RAIN LEADER
SLOPED ROOF
RAIN LEADER
1m
STORM BUILDING
DRAIN 1 IN 100
STORM BUILDING
SEWER 1 IN 100

Summary:

Rain Leader for the flat roof = 4 inch
Rain Leader for the sloped roof = 3 inch
Horizontal Storm Building Drain for the flat roof = 5 inch
Horizontal Storm Building Sewer = 6 inch

EXERCISE 2-15

For the building shown in Figure 2:9 and 2:10, located in Bancroft, determine the size of the following pipes:

- rain leaders 1, 2 and 3
- horizontal storm drain
- horizontal storm sewer

Figure 2:9 Storm Drainage Piping Exercise

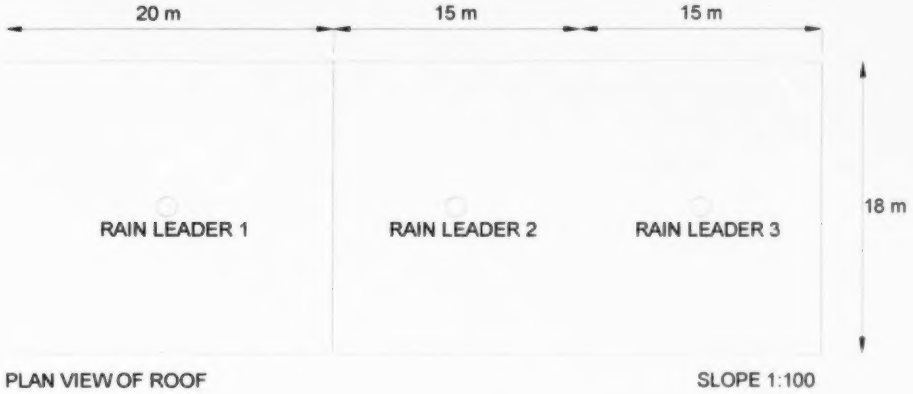
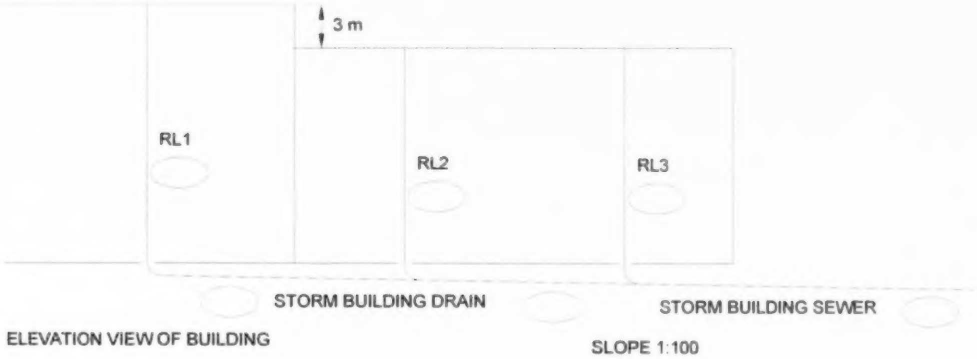

20 m
15 m
15 m
18 m
RAIN LEADER 1
RAIN LEADER 2
RAIN LEADER 3
PLAN VIEW OF ROOF
SLOPE 1:100

Figure 2:10 Storm Drainage Piping Exercise (Elevation View)

Fill in the answers in the ovals provided on the elevation below.


3 m
RL1
RL2
RL3
STORM BUILDING DRAIN
STORM BUILDING SEWER
ELEVATION VIEW OF BUILDING
SLOPE 1:100

Calculations:

MODULE 2 QUIZ

1. A Fixture unit (as applying to the drainage system) is

(a) unit of measure based on the rate of discharge
(b) unit of measure based on the rate of supply
(c) a plumbing appliance
(d) a plumbing receptacle
Code Ref: ________________

2. Sanitary sewage means liquid or water borne wastes of:

(a) industrial or commercial origin
(b) domestic origin
(c) toilet or other bathroom waste
(d) residential occupancies
Code Ref: ________________

3. When can a minimum sized soil or waste pipe be connected to a smaller drainage pipe?

(a) when the discharge is not from a sanitary unit
(b) when a horizontal branch draining 3 water closets connects to a 3″ soil stack
(c) connection of any horizontal branch to a vertical stack
(d) a connection to a smaller sized drainage pipe is not permitted
Code Ref: ________________

4. The maximum number of water closets that may be served by a 3" horizontal branch is::

(a) 1
(b) 2
(c) 3
(d) 5
Code Ref: ________________

5. Every soil stack that serves more than 6 water closets shall be at least:

   (a) 3 inch
   (b) 4 inch
   (c) 5 inch
   (d) 6 inch

   Code Ref: ____________________

6. The part of the fixture outlet pipe that is common to 3 compartments of a sink shall be:

   (a) 1½ inch
   (b) 2 inch
   (c) one size larger than the largest fixture outlet pipe
   (d) one size larger than the smallest fixture outlet pipe

   Code Ref: ____________________

7. Every soil or waste stack shall be provided with a clean out:

   (a) at the bottom of the stack
   (b) not more than 1.5 metres upstream of the bottom of the stack
   (c) on a T-Y fitting connecting the stack to the building drain
   (d) a cleanout is not required

   Code Ref: ____________________

8. Indirect connections may be installed:

   (a) in crawlspaces
   (b) in a floor joist system with a ceiling attached to underside
   (c) below the concrete floor only when slab on grade
   (d) in an accessible location

   Code Ref: ____________________

9. The sequence of valves on a discharge pipe from a sewage ejector is:

7.4.10.8.(2)

(a) union, check valve, shut off
(b) shut off, union, check valve
(c) check valve, shut off, union
(e) it doesn't matter as long as all three are installed
Code Ref: ___________________

10. The maximum loading on horizontal drainage pipe is:

(a) 30%
(b) 29%
(c) 65%
(e) 100%
Code Ref: ___________________

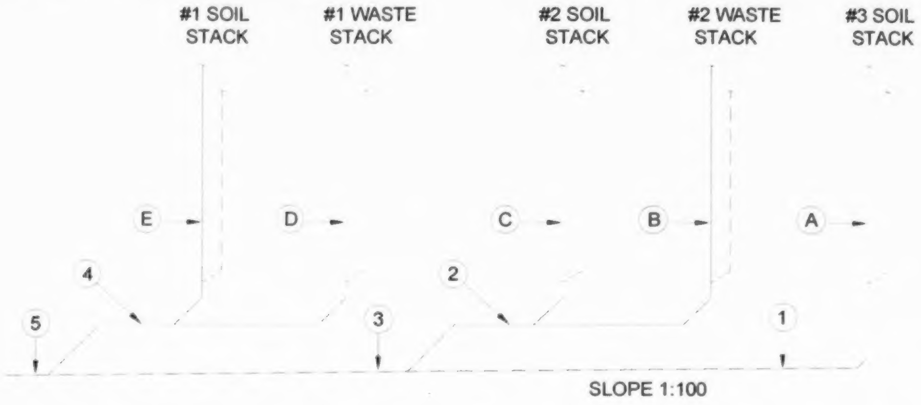
11. What is the size of a vertical stack serving 4 storeys with the following loading:

- First Floor – 6 Fixture units
- Second Floor – 6 fixture units
- Third Floor – 4 fixture units
- Fourth Floor – 4 fixture units

Code Ref: ___________________

12. Size the drains in Figure 2:11. The building is 4 storeys in building height. All toilets are the flush tank type. The horizontal drain on the bottom is the building drain. There are a maximum of 2 water closets per floor on any one stack.

Figure 2:11 Quiz Drain Sizing


#1 SOIL STACK
#1 WASTE STACK
#2 SOIL STACK
#2 WASTE STACK
#3 SOIL STACK
E
D
C
B
A
4
2
5
3
1
SLOPE 1:100

Stack No.	Fixtures	F.U.s	Total F.U.s
Soil Stack 1	6 - bathroom groups		
	6 - kitchen sinks		
Waste Stack 1	6 – 3 in. floor drains		
	6 – 1 ½ in auto washers		
Soil Stack 2	3 – bathroom groups		
	3 – kitchen sinks		
Waste Stack 2	3 – 2 in. floor drains		
	3 – 1 ½ in. auto washers		
Soil Stack 3	2 – bathroom groups		
	2 – kitchen sinks		
	2 – 2 in. floor drains		
	2 – 1 ½ auto washers		

Location	Fixture Units/Sizing Considerations	Pipe Size
A		
B		
C		
D		
E		
1		
2		
3		
4		
5		

MODULE 3

TRAPS

PLUMBING – ALL BUILDINGS - 2007

MODULE CONTENTS

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Types of Traps 3.6

Common Traps 3.6

Special Use Traps 3.7

Prohibited Traps 3.9

Trap Seal Loss 3.13

Module Quiz 3.20

LEARNING OBJECTIVES

Upon completion of this module, participants will be able to:

- State the purpose of a trap
- Identify the parts of a trap
- Identify the different types of traps and their uses
- Identify prohibited and permitted traps
- Describe how and why a trap seal is lost
- State the code requirements for connection between a fixture trap and its vent

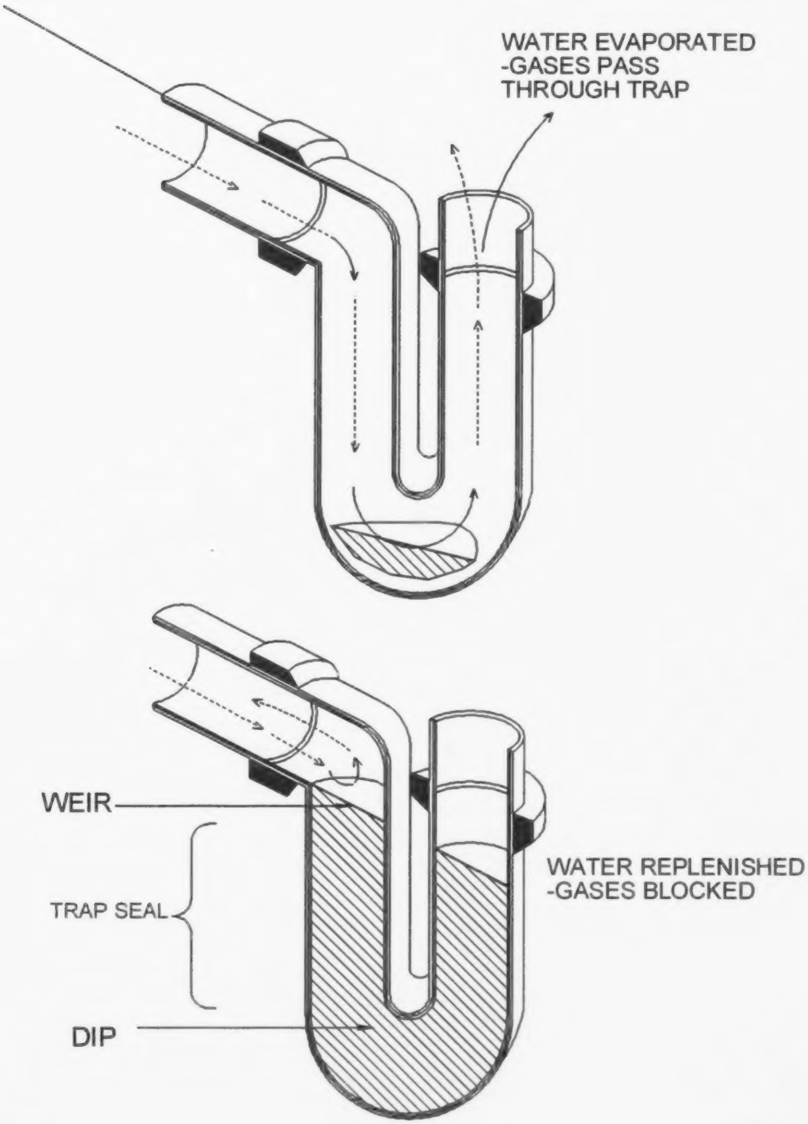
INTRODUCTION

According to Division A, Part 1 of the Code, a **trap** means a fitting or device that is designed to hold a liquid seal that will prevent the passage of gas but will not materially affect the flow of a liquid.

The main purpose of a **trap** is to allow liquid to flow from the fixture and also prevents sewer gases from entering the building. The weight of the water retained in the trap is too great to be displaced by air pressures on the sewer side of the trap, consequently no air or gas from the sewer side may pass back into the fixture.

A figure showing how a trap works is on the next page.

FIGURE 3:1 How a Trap Works


WATER EVAPORATED
-GASES PASS
THROUGH TRAP
WEIR
TRAP SEAL
DIP
WATER REPLENISHED
-GASES BLOCKED

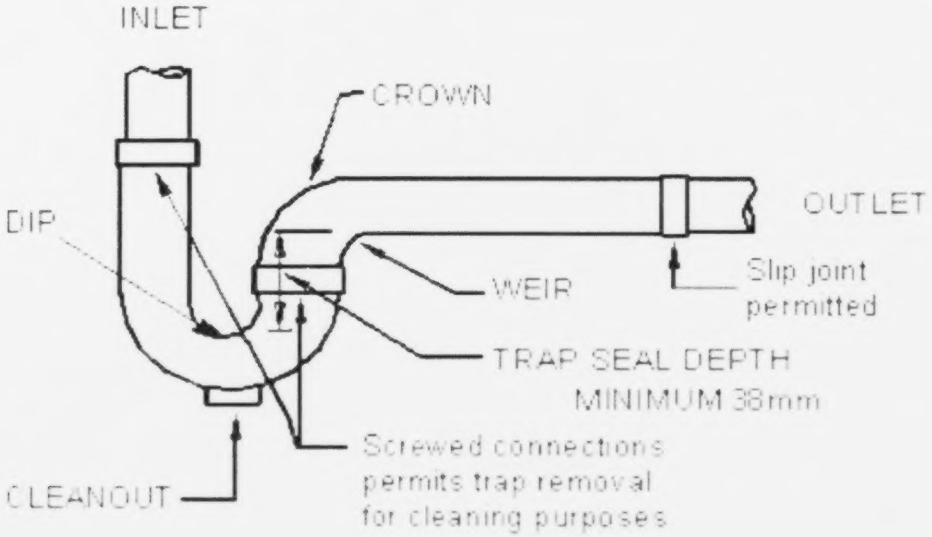
The purpose of a trap is reinforced by one of the key objectives linked to requirements for traps, OH1.1 (Health, Indoor Conditions):

> *An objective of this Code is to limit the probability that, as a result of the design or construction of a building, a person in the building will be exposed to an unacceptable risk of illness due to indoor conditions caused by inadequate indoor air quality.*

Every trap has identifiable parts such as trap dip, trap seal depth, trap weir, inlet and outlet. Also, some traps require cleanout plugs or be designed to be able to be removed to permit removal for cleaning purposes.

Some fixtures such as bathtubs, showers, floor drains, do not require cleanouts or the ability to be removed because of their location (see Sentence 7.2.3.1.(3) of the Code). Figure 1B shows a trap with a cleanout plug and provided with screw connections.

FIGURE 3:2 Parts of a Trap


INLET
CROWN
OUTLET
DIP
WEIR
Slip joint permitted
TRAP SEAL DEPTH MINIMUM 38mm
Screwed connections permits trap removal for cleaning purposes
CLEANOUT

There have been lots of different types of traps over the years, some often unnecessarily complicated. The good qualities of a trap are basic and few. These qualities are:

- No ledges, corners or partitions to restrict flow or collect solid matter
- Smooth bore throughout, which encourages self cleansing
- A means of access for cleaning
- No mechanical parts which could malfunction
- No washers or packing on the "sewer" side that could rot away and cause undetected leakage of sewer gas.

Complete the following exercises on your own. Check your answers with the other members within your group. Have your spokesperson put the answers on the flip chart.

EXERCISE 3-1

1. As stated before, some fixtures traps do not require cleanouts. Name the fixtures that require traps to be served with cleanouts or a design that permits removal of the trap.

____

____

____

Code Ref:__________________________________

2. What is the minimum depth seal of a trap?

____

____

____

Code Ref:__________________________________

STOP

TRAP ARMS

We looked at trap arms in Module 3 on Venting. The 2006 OBC defines a **trap arm** as that portion of a fixture drain between the trap weir and the vent pipe fitting. The developed length of every fixture outlet pipe shall not exceed 1 200 mm per 7.4.8.2. of the code.

Keep these things in mind when you are thinking about traps and how they work.

TYPES OF TRAPS

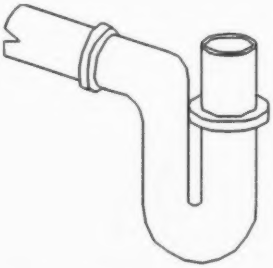
Review the following information on types of traps and do the exercises that follow. Class discussion will start in 20 minutes.

COMMON TRAPS

P-Trap

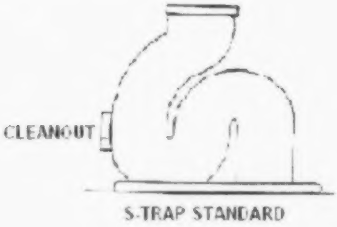
The most common type of fixture trap is the "P" trap, so named because it takes the shape of that letter

Figure 3:3 P-Trap



A **trap standard** is an integral trap that forms the support for the fixture. Service sinks, commonly known as slop sinks, have a trap standard.

Figure 3:4 S-Trap Standard



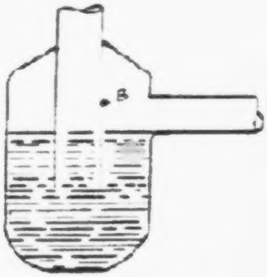
SPECIAL USE TRAPS

Bottle Trap - A bottle trap may be used in a plumbing system where it connects to a laboratory sink or other fixture equipped with corrosion resistant fittings (Sentence 7.2.3.1.(7)). The bottle trap gets its name from the bottle shape of the trap. Its main advantage is that it has a large body, which is capable of storing more liquid and can intercept solid matters (valuables, plaster, etc.) which might otherwise be lost or cause blockage problems downstream in the system.

One disadvantage of this trap is that the body is large and does not permit self-cleansing. The second disadvantage of this trap is the possibility of an undetected sewer gas leak should a hole develop in the pipe inside the "bottle" and above the water seal.

Trace the path of sewer gas if point B represents a hole in the wall

Figure 3:5 Bottle Trap



Building Trap and Running Trap - The main trap of the house is better known as a building trap. However, it can also be considered as a running trap. The purpose of the building trap is to prevent the passage of air, odours, gases and vermin from the street sewer into the building.

Other running traps shall not be used in a plumbing system unless an accessible handhole is provided for cleaning. If the trap is too small to accommodate a handhole, a cleanout shall be provided. When a running trap is installed in a building drain it prevents a continuous flow of air throughout the plumbing system.

Read Article 7.4.5.4. and look at Figure 3:6 below:

Figure 3:6 Running Trap

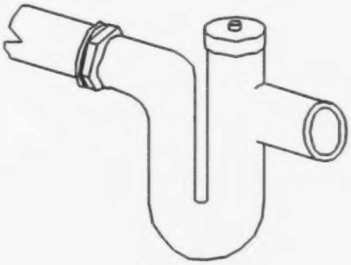
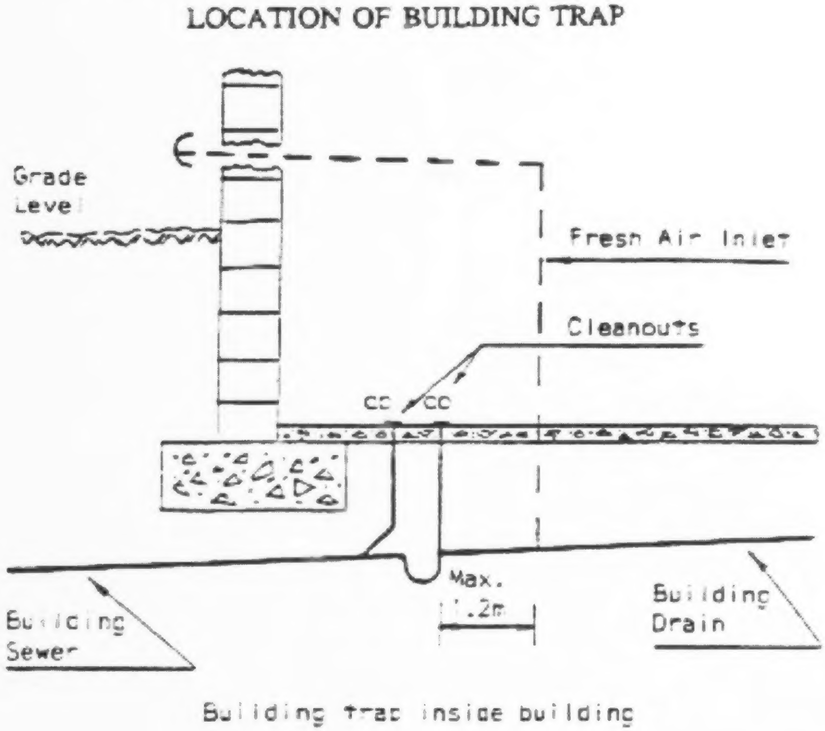


Figure 3:7 Building Trap

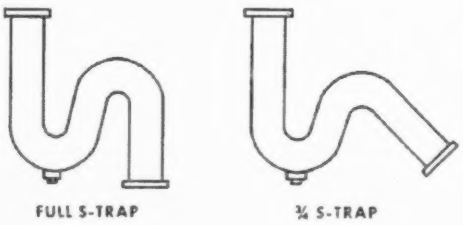

LOCATION OF BUILDING TRAP
Grade Level
Fresh Air Inlet
Cleanouts
CO
CO
Max. 1.2m
Building Sewer
Building Drain
Building trap inside building

PROHIBITED TRAPS

Some of the traps that are prohibited by the Code are:

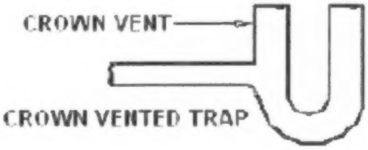
S-traps and ¾ **S-traps** are prohibited by Sentence 7.2.3.1.(4) because they can cause self siphonage and they also exceed the maximum fall permitted before the attachment of a vent pipe.

Figure 3:8 S-Trap and ¾ S-Trap


FULL S-TRAP
¾ S-TRAP

Crown vented traps are prohibited because they have a tendency to get clogged and the trap seal is subject to evaporation since the vent pipe is so close. These traps are prohibited by virtue of the minimum length of a trap arm in Clause 7.5.6.3.(1)(a) – not less than twice the size of the fixture drain, measured from the trap weir to the vent pipe.

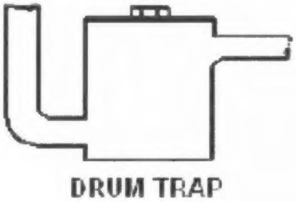
Figure 3:9 Crown Vented Trap



Drum Trap

Drum traps are prohibited in Sentence 7.2.3.1.(5) because these traps have a tendency to clog.

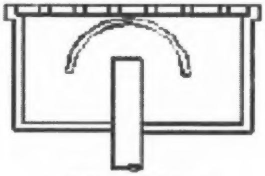
Figure 3:10 Drum Trap



Bell Trap

Bell traps were used as traps for floor drains, but they have a large surface area and tend to evaporate and dry out. The trap can also clog due to the sharp edges in its design. For these reasons, the bell trap is prohibited under Sentence 7.2.3.1.(4).

Figure 3:11 Bell Trap



EXERCISE 3-2

1. Are S-traps allowed in a plumbing system? Explain why.

Code Ref:

2. Where can a bottle trap be used?

Code Ref:

3. Explain the disadvantage of a bottle trap.

4. What is the most common type of trap used?

STOP

TRAP SEAL LOSS

"Trap seal loss" means a partial or complete loss of liquid that forms the seal in the trap. As stated before, the only purpose of the trap is to retain a body of liquid and thus prevent the entry of sewer gas into the building. Sewer air contains gases resulting from decomposition of fats, soap, solid wastes, and also from commercial and industrial refuse discharged into the sewers.

Many of these gases present in the sewer air are obnoxious and may consist of methane, acetylene, hydrogen, ammonia, carbon dioxide, oxygen and nitrogen. Hydrogen sulfide and carbon monoxide are highly poisonous, even in relatively small concentrations.

With the uncertainties of dangers resulting from the admission of gases from sewers and drainage pipes into buildings, the greatest of efforts must be made to confine sewer air to sewers. This is achieved through maintaining a trap seal.

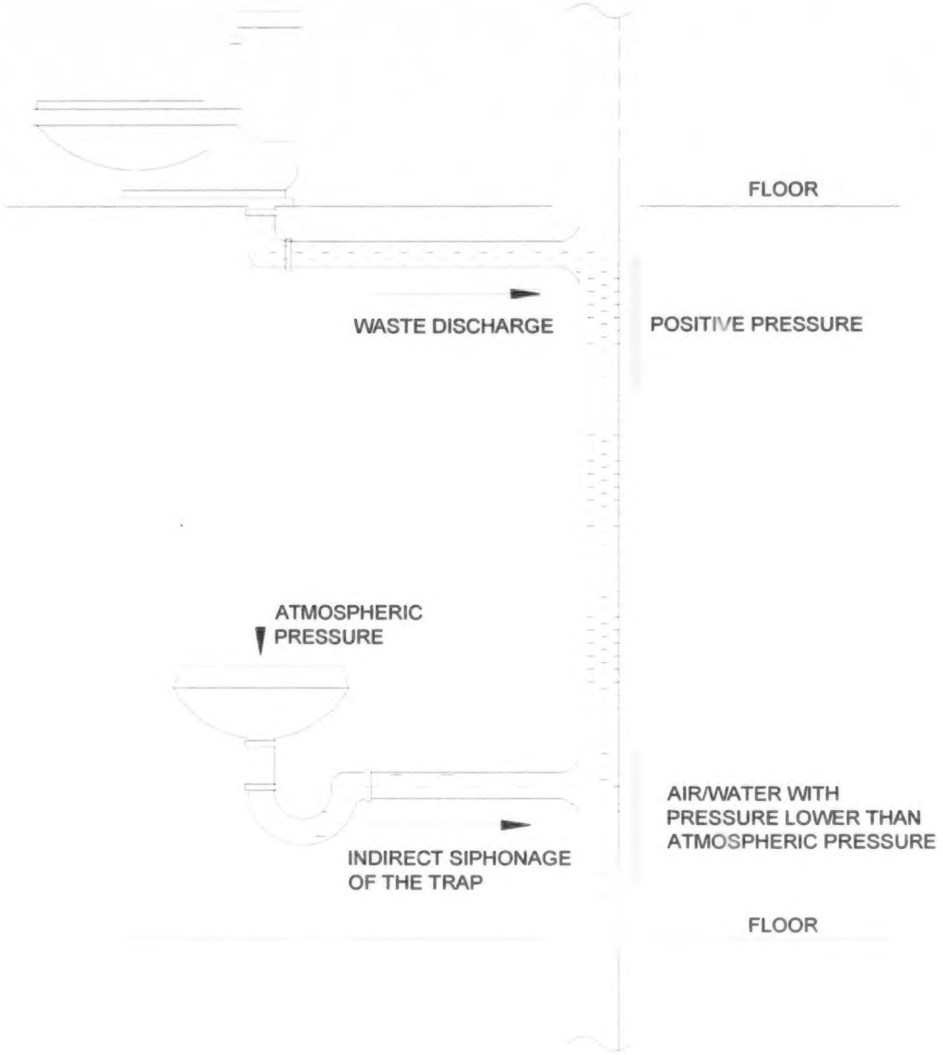
To provide adequate protection against trap seal loss, it is necessary to understand the conditions and phenomena that cause it. Some of these conditions are:

1. Self siphonage
2. Indirect siphonage
3. Back pressure
4. Evaporation
5. Leakage
6. Oscillation
7. Capillary action
8. Momentum

Self siphonage is the reduction of pressure against the downstream surface of water in the trap by creation of an un-vented column of water in the drain pipe continuous with and downstream from the water in the trap.

When a trap seal is lost by what is commonly known as "**indirect siphonage**", it is not because of the shape of the trap or waste pipe as in self siphonage. The loss of the seal results from the discharge of some other fixture, usually at a higher level. The flow of waste causes a reduction of atmospheric pressure downstream from the trap seal. Atmospheric pressure then pushes the seal out into the waste pipe, thus the term "indirect".

Figure 3:12 Indirect Siphonage


FLOOR
WASTE DISCHARGE
POSITIVE PRESSURE
ATMOSPHERIC PRESSURE
AIR/WATER WITH PRESSURE LOWER THAN ATMOSPHERIC PRESSURE
INDIRECT SIPHONAGE OF THE TRAP
FLOOR

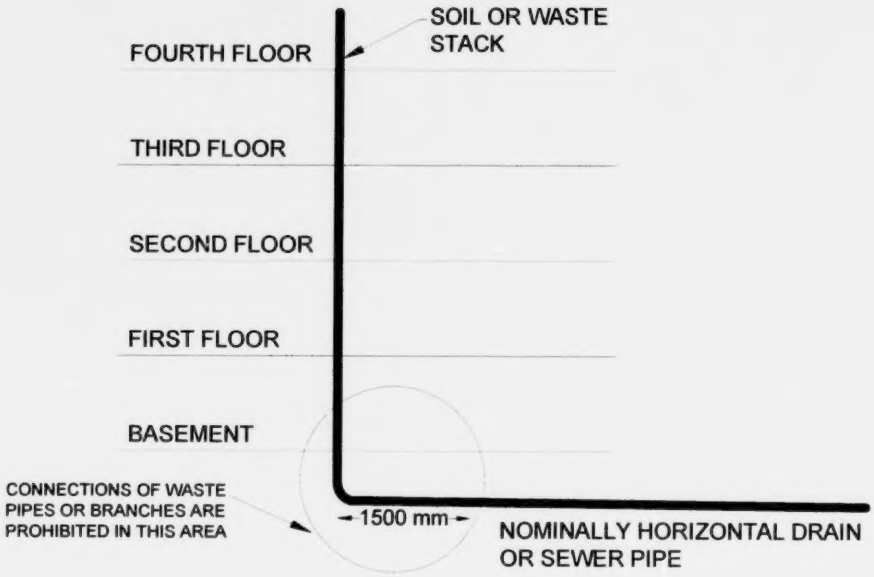
Assume that the fixtures in Figure 5 are on separate floors. The discharge of the upper sink will result in a reduction of atmospheric pressure in the waste pipe of the lower sink, as the waste passing point 'A' tends to draw out some of the air.

The atmospheric pressure acting on the surface of the seal (on the fixture side) is then suddenly greater than the reduced pressure on the sewer side, causing the seal to be pushed into the waste pipe. An occupant in the room would hear a gurgling sound as air is sucked under the dip of the trap.

Indirect siphonage is addressed by the Code requirements for adequate sizing of drainage pipes and venting requirements.

Back pressure is caused by excessive pressure created in a waste pipe when the air within a stack is pushed into a waste pipe or branch at a lower elevation by drainage coming from a higher elevation. Usually the waste pipe or branch affected would be connected to the horizontal main at the bottom of stack. This would be more common in high rise buildings where velocities within stacks can be obtained. Sentence 7.4.2.1.(2) states that a connection to the horizontal piping within 1500 mm of the base of the stack is **prohibited** where it receives discharge from 30 or more fixture units, or discharge from fixtures located on two or more floors.

Figure 3:13 Back Pressure


SOIL OR WASTE STACK
FOURTH FLOOR
THIRD FLOOR
SECOND FLOOR
FIRST FLOOR
BASEMENT
CONNECTIONS OF WASTE PIPES OR BRANCHES ARE PROHIBITED IN THIS AREA
1500 mm
NOMINALLY HORIZONTAL DRAIN OR SEWER PIPE

Siphonage and self-siphonage are more undesirable than back pressure because siphonage removes water from the trap so the strength of the seal is weakened or destroyed, whereas after back pressure is removed, water may flow from the fixture to restore the seal.

Where traps are infrequently used the trap seal loss can be caused by **evaporation**. Main factors for the time it takes a trap to evaporate are air movement, percentage of moisture in the air, area of water surface exposed and temperature.

Evaporation of trap seals for floor drains or hub drains is addressed in Sentence 7.4.5.5. A "trap seal primer" maintains the trap seal by a small diameter pipe or tube that is connected to a drinking fountain or other fixture, so that water from that fixture will feed into the floor drain trap. Prefabricated floor drains are often equipped with tapping to connect to a primer line.

Leakage of a trap can also cause trap seal loss. The leak could be caused by a number of things. Improper installation, clean out plug not tightened, etc.

High winds blowing over the stack terminal can cause rapid fluctuations of air pressure within the drainage and vent system. This causes **oscillating** (back and forth rocking) movement of trap seals with some spillage into the waste pipe each time the water slops up and over the trap weir. This is usually a temporary condition due to weather. There is not much that can be done other than relocating the stack terminal.

Capillary action is caused by suspension of a foreign object such as hair, a rag, string or lint into the trap seal extending over the trap weir. It soaks up water until it drops from the end reaching into the outlet of the trap.

Momentum is caused where a vertical section of fixture outlet pipe is excessive. The maximum developed length of a fixture outlet pipe shall not exceed 900 mm. It is possible to pull the trap seal if the vertical distance is more.

EXERCISE 3-3

1. Define trap seal loss.

____

____

2. Read Section 7.4.5.5. What does the code say about maintaining a trap seal?

____

____

____

Code Ref:____________________________________

3. Discuss with your group what other methods are acceptable for priming a floor drain.

Code Ref:

4. Give two examples where siphonage of a trap may occur.

5. Describe how you could correct the above examples.

STOP

MODULE 3 QUIZ

1. The purpose of a trap is to:

   (a) prevent the entry of sewer gas and foul odours into the building from the sewer
   (b) trap small objects so they can be recovered
   (c) assist the venting system
   (d) all of the above

2. The most common type of trap used today is:

   (a) S-trap
   (b) trap standard
   (c) building trap
   (d) P-trap

3. A trap standard is:

   (a) a regulation that all traps must conform to
   (b) an integral trap which forms the support for the fixture
   (c) a trap used to connect a laboratory sink
   (d) a large trap capable of intercepting solid matters such as valuables, plaster, etc.

4. Some of the gases found in the sewer air are:

   (a) methane
   (b) carbon dioxide
   (c) oxygen
   (d) ammonia
   (e) all of the above
   (f) (a) & (b)

5. Indirect siphonage is caused by:

   (a) the discharge of a fixture at a higher level
   (b) excessive pressure in a waste pipe
   (c) suspension of a foreign object extending over the trap weir
   (d) high winds blowing over the stack terminal

6. Problems associated with a crown vented trap are:

   (a) clogging materials splash into the vent pipe
   (b) cannot be used as a wet vent
   (c) evaporation of trap increases as vent is too close to the trap
   (d) both (a) and (c)

7. The code requires that the following traps shall not be used in a drainage system:

   (a) bell trap
   (b) bottle trap
   (c) drum trap
   (d) all of the above
   (e) both (a) and (c)

   Code Ref:____________________

8. Every trap must be:

   (a) individually vented
   (b) provided with a handhole cleanout
   (c) provided with a cleanout plug
   (d) none of the above
   Code Ref:____________________

9. Connection of a soil or waste pipe to a nominally horizontal soil or waste pipe shall be at least 1 500 mm measured horizontally from the bottom of a soil or waste stack that:

   (a) receives a discharge of 30 or more fixture units or discharges from fixtures on 2 or more storeys
   (b) receives a discharge of 30 or more fixture units and discharges from fixtures on 2 or more storeys
   (c) receives a discharge from 30 or more fixtures or discharges from fixtures on 2 or more storeys
   (d) receives a discharge from 30 or more fixtures and discharges from fixtures on 2 or more storeys
   Code Ref:____________________

10. Full S-Traps and 3/4 S-Traps are not permitted because;

    (a) their shapes cause oscillation of the seal
    (b) they exceed the maximum permitted fall
    (c) the sharp turns cause debris to accumulate and cause blockage
    (d) the shape of the trap causes indirect siphonage
    (e) (b) and (d)

    Code Ref:____________________

END OF MODULE

MODULE 4

VENTING

PLUMBING – ALL BUILDINGS - 2007

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In this module, we will learn the theory of a venting system, venting terms, the sizing of vent pipes, different methods of venting, and code requirements from **Division B, Part 7** that deal with venting. There has been significant changes to venting requirements in the 2006 OBC. The new requirements are harmonized with the National Plumbing Code.

LEARNING OBJECTIVES

Upon completion of this module, participants will be able to:

- Define venting terms.
- Explain the theory of a venting system.
- Differentiate between methods of venting.
- Determine the loading and sizing of vent pipes.
- Identify compliance and non-compliance with the Ontario Building Code.
- Understand the objectives of key venting requirements

STOP

INTRODUCTION TO VENTING SYSTEMS

The venting of a plumbing system is that portion of the installation designed to maintain atmospheric pressure within the drainage system. When liquid wastes are discharged into the plumbing system, the wastes displace air, which in turn causes changes of pressure within the system. It is necessary to provide escape routes for any excess pressures, and supply routes for make-up air to relieve vacuum conditions wherever they occur.

Vent piping provides circulation of air within such a system and protects the trap seal from self-induced trap siphonage, indirect trap siphonage and back pressure. Efficient venting also prevents the deterioration of the materials used in the drainage system by venting corrosive gases out of the system.

The goal of proper venting is to provide for a balance of air within the drainage system so that positive and negative pressures will not exceed one inch of water at the trap seal of the fixture. Maintaining the balance of air pressure ensures that the trap seals function as designed, and prevents odours from entering the building.

Venting systems are addressed primarily in Division B, Section 7.5.

OBJECTIVES AND FUNCTIONAL STATEMENTS

The objectives of the 2006 OBC are set out in Division A, Sentence 2.2.1.1(1). Some **key objectives linked to venting** are listed below.

EXERCISE 4-1

Complete the following exercise by filling in the blanks, then discuss your answers with your group. The first objective is completed as an example.

Objective No.	OBC Objective
OH1.1	An objective of this Code is to limit the probability that, as a result of the design or construction of a building, a person in the building will be exposed to an unacceptable risk of illness due to indoor conditions caused by inadequate indoor air quality.
OH2.1	An objective of this Code is to limit the probability that, as a result of the design or construction of a building, a person in the building will be exposed to an unacceptable risk of illness due to ________________ conditions caused by ______________________________________.
OH2.3	An objective of this Code is to limit the probability that, as a result of the design or construction of a building, a person in the building will be exposed to an unacceptable risk of illness due to ________________ conditions caused by ______________________________________.
OS1.1	An objective of this Code is to limit the probability that, as a result of the design or construction of a building, a person in or adjacent to the building will be exposed to an unacceptable risk of injury due to fire caused by ____________________________________ explosion.
OS3.4	An objective of this Code is to limit the probability that, as a result of the design or construction of a building, a person in or adjacent to the building will be exposed to an unacceptable risk of injury due to ___________ caused by ______________________________.

There are four functional statements that are linked to venting requirements.

F40 To limit the level of contaminants.

F72 To provide facilities for the sanitary disposal of human and domestic wastes.

F80 To resist deterioration resulting from expected service conditions.

F81 To minimize the risk of malfunction, interference, damage, tampering, lack of use or misuse.

Supplementary Standard SA-1 shows the specific functional statements for each requirement.

STOP

TYPES OF VENTS AND VENTING TERMS

Many forms of venting can be applied to the plumbing installation. Choice is determined largely by the manner in which the plumbing fixtures are to be located and grouped. As a rule the completed vent pipe system is a combination of several methods, and each has a function in the plumbing system. These various types may be grouped under two classifications:

1. The vent pipes used to ventilate the soil and waste pipes are vent stacks, stack vents, offset relief vents and yoke vents . These methods of venting serve the fixture trap only in an indirect way. Their primary purpose is to maintain atmospheric pressure in the drainage system.

2. The venting method whose primary purpose is to protect the traps against back pressure and siphonage, are individual or back vents, continuous vents, wet vents, and circuit vents.

Types of vents are listed in Sentence 7.5.1.1.(1). You may be familiar with these terms already, but some of these terms may be new to you.

In this module we will review the location of vent pipes, review the types of vents in detail before learning more about when each type of vent is used, and how to size the vents.

It is recommended that you consult the definitions in Division A and write these down in each exercise. It may also be helpful to write a definition in your own words.

STOP

LOCATION OF VENT PIPES

As you have already learned, each waste pipe is connected to a trap that serves the fixture. The waste pipe must be installed properly to ensure the waste flows away smoothly, quietly and does not siphon the trap. The pipe that connects a trap serving a fixture to another part of the drainage system is called a fixture drain.

The 2006 OBC includes a new term, **trap arm**, which means that portion of a fixture drain between the trap weir and the vent pipe fitting.

Five factors must be considered when inspecting a trap arm:

1) minimum length
2) minimum slope
3) maximum length
4) total fall
5) maximum change in direction

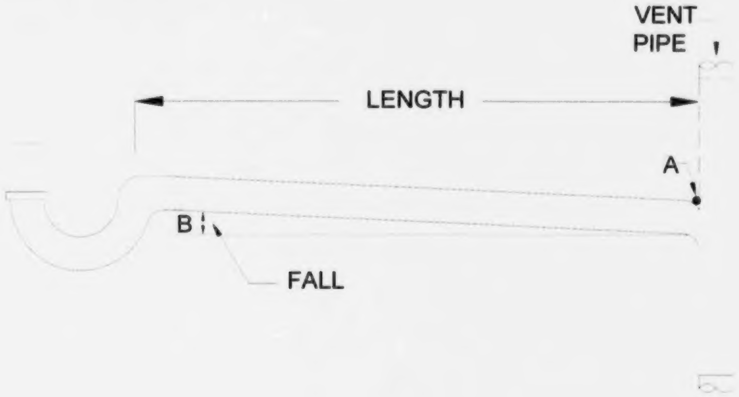
A crown vent is a vent connected to a fixture waste pipe on top of the crown of the trap. This is not acceptable in a plumbing system because of the close proximity of the trap. Experience has shown that grease, hair and other clogging materials splash into the vent pipe to accumulate there and finally close the vent. Also there is some evidence that because the vent is so close to the water that surface evaporation is increased. This is why the code requires the **minimum length** of the trap arm to be not less than twice the size of the fixture drain.

In order to promote self-cleansing flow, the **minimum slope** in the direction of flow is 1 in 50 for trap arms as shown in Table 7.5.6.3.

There are two reasons for establishing **maximum distance** between a trap and its vent. Remember that one end of the waste pipe is blocked with the trap, and it is also desirable to have fresh air circulating through the drainage piping to carry away gases. Therefore the farther away the vent, the more piping that is not ventilated.

Another reason for establishing a **maximum distance** is to prevent the loss of a trap seal through self-induced siphonage. The loss of a trap seal could occur if the highest point ("A" in Figure 4:1) is lower than the weir level of the trap.

Figure 4:1 Trap Arm Length and Fall



The maximum distance of a trap arm in the 2006 OBC depends on the size of trap served.

The maximum distance of a trap arm is still 1.5 metres for traps up to 2 inches. This ensures that in the case of the smallest size waste pipe (1 ¼ inch), the point at which air is admitted to the waste pipe, when minimum slope is applied, is not lower than the weir level.

Greater distances are permitted for larger traps, and a trap arm can be up to 5 metres for a 6 inch pipe. See Table 7.5.6.3. for all trap sizes.

There is a fixed relationship between the maximum distance allowed between a trap and its vent, the minimum slope and the total fall. The code requires that the **total fall** of the trap arm is not greater than its inside diameter. The reason for this is the same as above – air should not be let into the waste pipe lower than the trap weir. The fall is indicated as "B" in Figure 4:1.

The code requires that the trap arm does not have a **cumulative change** in direction of more than 135 degrees (with the exception of water closets, see 7.5.6.3.(2)). This allows the flow of waste to move with as little restriction as possible.

Example: 135 degrees can be reached by many combinations of bends, including:

- three 1/8 bends
- one 1/8 bend and one 1/4 bend

EXERCISE 4-2

For each requirement below, put down the code reference and describe in your own words why the requirement is important.

1. The **minimum length** of a trap arm.
   OBC Reference:

Code Ref:

2. The **minimum slope** of all trap arms.
   OBC Reference:

Code Ref:

3. The **maximum length** of a trap arm. Explain why the permitted length increases as the trap size increases.
   OBC Reference:

Code Ref:

4. The **total fall** in the trap arm.
OBC Reference:

Code Ref:

5. The **change in direction** permitted in a trap arm.
OBC Reference:

Code Ref:

6. The **location** of a vent pipe serving a **water closet**.
OBC Reference:

Code Ref:

STOP

VENT PIPES, CONTINUOUS VENT, BACK VENT

As previously discussed, the venting system exists to protect trap seals in a drainage system. So let's start with the vent terms that are closest to the traps.

Sentence 7.5.1.1.(1) states that every trap shall be protected by a **vent pipe**.

EXERCISE 4-3

The definition of **vent pipe** is:

____

____

____

Code Ref:__________________________________

The terms **individual vent** and **dual vent** are generally taken to mean a vent that serves an individual trap or a vent that serves two traps.

The term **continuous vent** is new in the 2006 OBC, and it replaces the previous term "continuous waste and vent".

EXERCISE 4-4

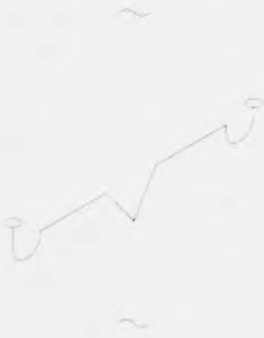
1. The definition of **continuous vent** is:

2. The definition of **back vent** is:

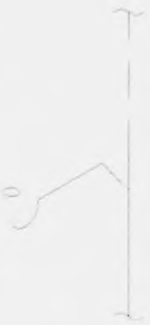
3. How does a **continuous vent** differ from a dry vent connected to a horizontal branch?

4. Label the drawings below appropriately.

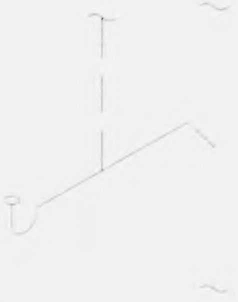
Figure 4:2 – Examples of Vents



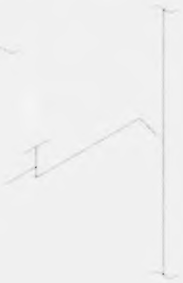
1.____________________



3.____________________



2.____________________



4.____________________

Sentence 7.5.1.1.(1) of the Code states that every trap (with a few exceptions) must be vented. Read Sentences (3) and (4) of Article 7.5.1.1. to see where venting is not necessary.

The implication of this Sentence is that a venting system typically requires a large number of vent pipes. Plumbers, however, like to economize on piping as much as permissible. This is done by sharing vents, by using stacks as vents, and by having a number of branch vents connect to a larger vent.

BRANCH VENT

A branch vent connects a two or more vents on one end and carries them over to a larger vent. The larger vent can be another branch vent, a vent stack, a stack vent, or a header. A branch vent is typically nominally horizontal, although there are no restrictions on its orientation.

EXERCISE 4-5

The definition of a **branch vent** is:

____

____

Code Ref:____

STOP

VENT STACKS

A vent stack is an efficient means of venting a multi-storey plumbing system. This type of vent serves as a terminal for smaller vents such as back vents, circuit vents, yoke vents, etc. It can be compared to a vent collection line. Also the vent stack provides air circulation to and from any part of the drainage system.

Definition from Division A: "Vent stack means a vent pipe that is connected at its upper end to a header or is terminated in open air and that is used to limit pressure differential in a soil or waste stack".

Vent stacks are required for every soil or waste stack greater than 4 storeys in height. Vent stack are typically designed only to carry fixture vents and not to contain any waste. However, a limited number of fixtures are permitted to be connected to a vent stack if the conditions in Clause 7.4.2.1.(1).(g) and Sentence 7.5.4.2.(4) are met.

The vent stack is connected to a **vertical section of the soil or waste stack** at or **immediately below the lowest soil or waste pipe** connected to the stack.

STACK VENTS AND HEADERS

A **stack vent** is a vent for a soil or waste stack. The definition in the Code is:

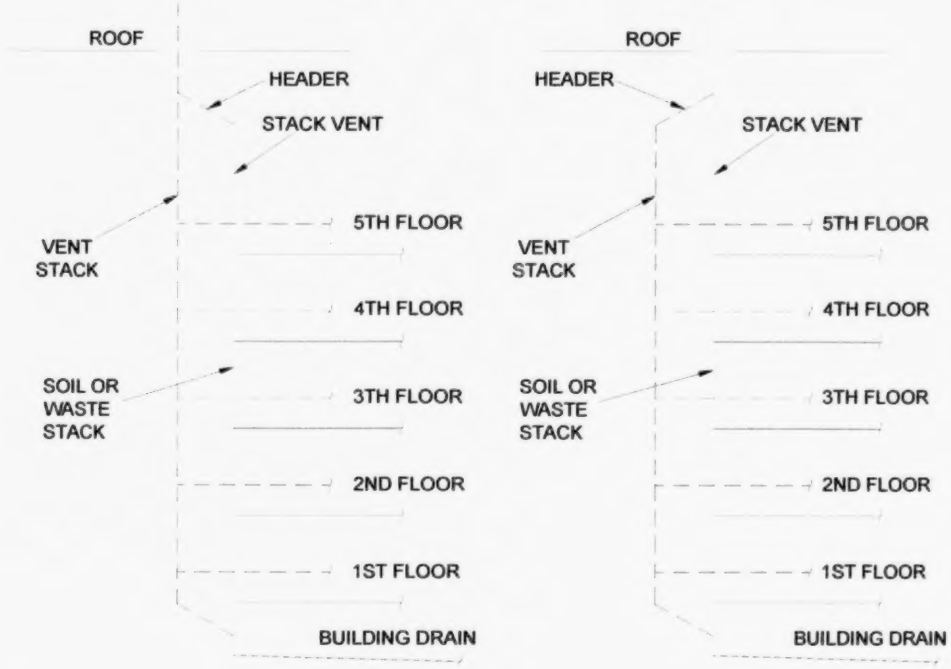
*A **stack vent** is a vertical vent pipe that extends from a soil or waste stack, and terminates at a header or in open air.*

The terms **vent stack** and **stack vent** are confusing when you hear them at first, and both provide a venting function. However, the difference is that a vent stack collects many vent pipes, and a stack vent vents only one soil or waste stack.

A **header** connects the tops of vent pipes and terminates in open air. A header can connect any combination of vent stacks, stack vents or other types of vents.

The figure below is an example of the relationship between vent stacks and stack vents.

Figure 4:3 Vent Stack and Stack Vent


ROOF
HEADER
STACK VENT
VENT STACK
5TH FLOOR
4TH FLOOR
SOIL OR WASTE STACK
3TH FLOOR
2ND FLOOR
1ST FLOOR
BUILDING DRAIN
ROOF
HEADER
STACK VENT
VENT STACK
5TH FLOOR
4TH FLOOR
SOIL OR WASTE STACK
3TH FLOOR
2ND FLOOR
1ST FLOOR
BUILDING DRAIN

Note: Figure represents two different buildings.

EXERCISE 4-6

Read Article 7.5.4.2. and answer the following questions.

1. When is a vent stack required? Is there an exception?

____

____

____

____

Code Ref:_____________________________________

2. List the conditions when fixtures are permitted to be connected to a vent stack.

a)

b)

c)

d)

e)

Code Ref:_____________________________________

3. Where can you find a stack vent? Where would you not find one?

____

____

Code Ref:_____________________________________

STOP

WET VENTING

A wet vent is simply a waste pipe that is also serving as a vent pipe.

Article 7.5.2.1. allows a soil or waste pipe to serve as a wet vent provided certain conditions are satisfied. Where the combination of fixture type and location is suitable, it is frequently more economical and simple to wet vent than to use some other form of venting.

One of the conditions is that the hydraulic load drained to a wet vent does not exceed what is permitted – Clause 7.5.2.1.(1)(a). This requirement is very important to ensure the wet vent will have adequate capacity to perform both drainage and venting functions.

We will look closer at hydraulic loading of the wet vent when we size the wet vent later in this module, but always keep in mind that loading on a wet vent is restricted.

There are a number of conditions for wet venting in Article 7.5.2.1. These conditions are examined individually below with corresponding figures.

Figure 4:4 Maximum 2 Wet Vented Water Closets

A **maximum of 2 water closets** can be wet vented on one stack - Clause 7.5.2.1.(1)(b)

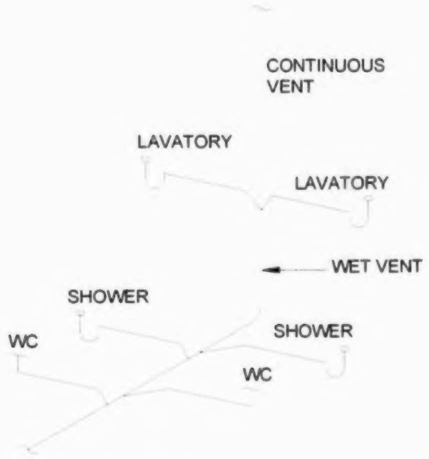
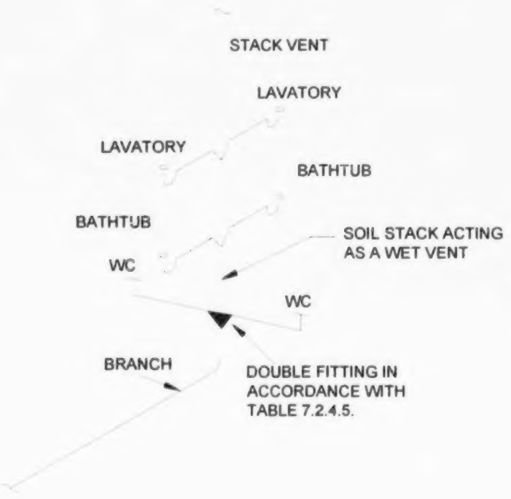


Figure 4:5 Wet Vented Water Closets Connected With a Double Fitting

If **2 water closets** are wet vented they must be **connected** at the same level to a vertical part of the stack with a **double fitting** - Clause 7.5.2.1.(1)(c)


STACK VENT
LAVATORY
LAVATORY
BATHTUB
BATHTUB
SOIL STACK ACTING AS A WET VENT
WC
WC
BRANCH
DOUBLE FITTING IN ACCORDANCE WITH TABLE 7.2.4.5.

Water closets must be downstream of all other fixtures - Clause 7.5.2.1.(1)(c)

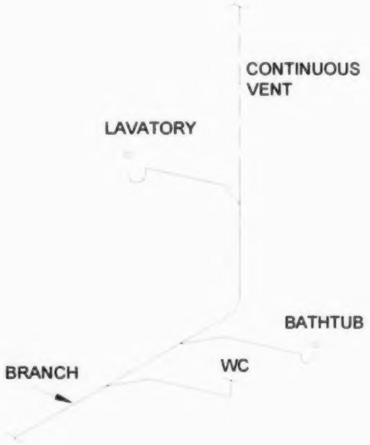

CONTINUOUS VENT
LAVATORY
BATHTUB
BRANCH
WC

Figure 4:7 Maximum Size of Wet Vented Drain Pipes

Maximum 2 in. size **trap arms** and fixture drains (except floor drains not less than 3 in. are permitted if installed as per 7.5.1.1.(3)) – Clause 7.5.2.1.(1)(e)

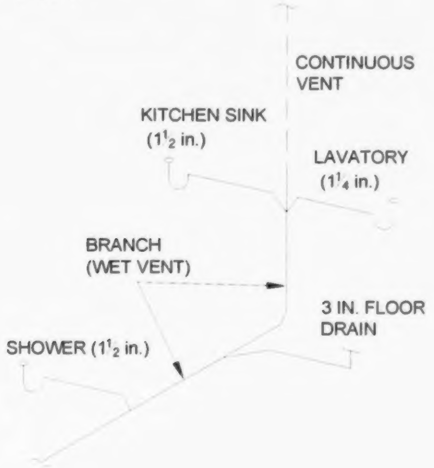

CONTINUOUS VENT
KITCHEN SINK (1½ in.)
LAVATORY (1¼ in.)
BRANCH (WET VENT)
3 IN. FLOOR DRAIN
SHOWER (1½ in.)

Figure 4:8 Separately Vented Fixtures Draining to a Wet Vent

Other **separately vented fixtures** on the same storey with a **total hydraulic load up to 2 fixture units** can drain to the wet vent - Clause 7.5.2.1.(1)(f)

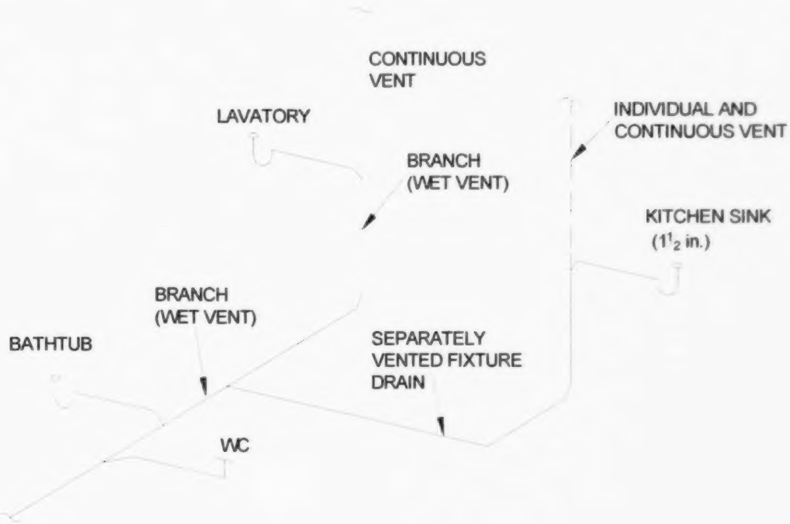

CONTINUOUS VENT
LAVATORY
INDIVIDUAL AND CONTINUOUS VENT
BRANCH (WET VENT)
KITCHEN SINK (1½ in.)
BRANCH (WET VENT)
BATHTUB
SEPARATELY VENTED FIXTURE DRAIN
WC

Figure 4:9 Multiple Storey Wet Vent - Maximum Hydraulic Load Per Storey

Wet vents can extend through multiple storeys, but the total hydraulic load drained to the wet vent is **a maximum of 4 fixture units per storey** – Clause 7.5.2.1.(1)(h)

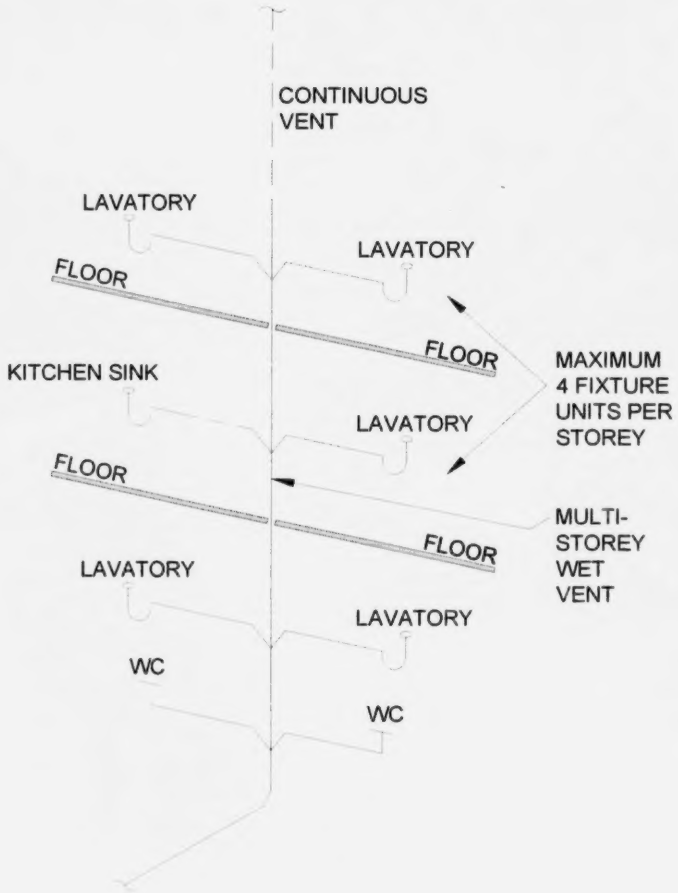

CONTINUOUS VENT
LAVATORY
LAVATORY
FLOOR
FLOOR
KITCHEN SINK
LAVATORY
MAXIMUM 4 FIXTURE UNITS PER STOREY
FLOOR
FLOOR
MULTI-STOREY WET VENT
LAVATORY
LAVATORY
WC
WC

Figure 4:10 Horizontal Offset of a Wet Vent

Only **one nominally horizontal offset** of a restricted length is permitted - Clause 7.5.2.1.(1)(i). Maximum length of offset is 1200 mm for pipes 2 in. or less in size, and 2500 mm for pipes larger than 2 in. in size.

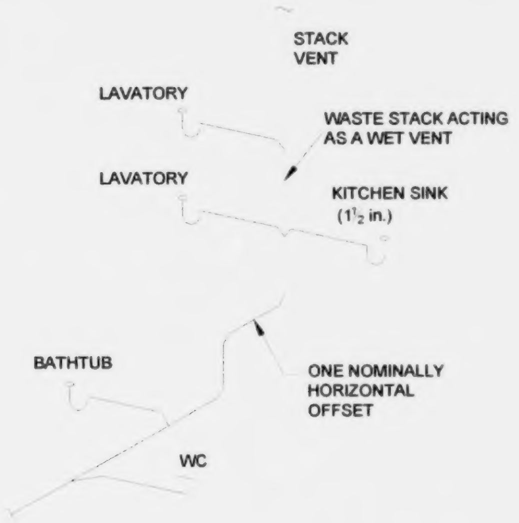

STACK VENT
LAVATORY
WASTE STACK ACTING AS A WET VENT
LAVATORY
KITCHEN SINK ($1\frac{1}{2}$ in.)
BATHTUB
ONE NOMINALLY HORIZONTAL OFFSET
WC

Figure 4:11 No Reduction in Size of a Wet Vent

The wet vent cannot be reduced in size except for the portion upstream of floor drains - Clause 7.5.2.1.(1)(j)

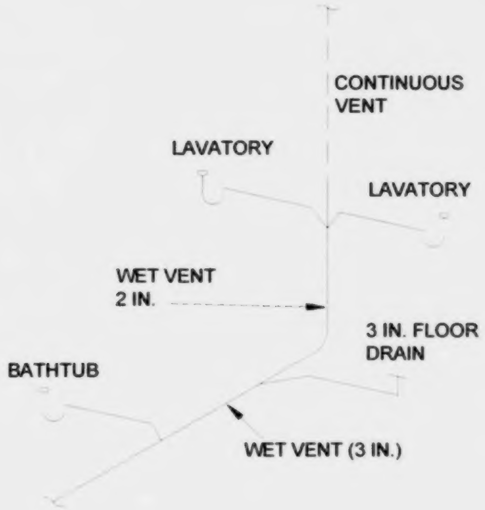
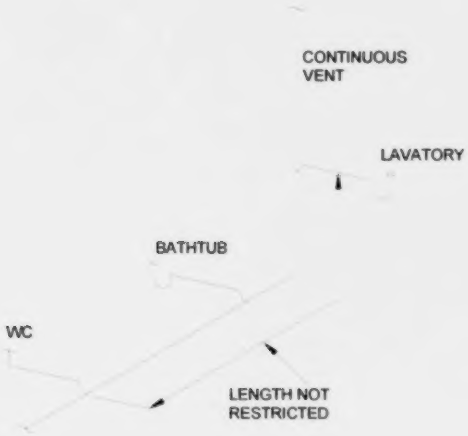

CONTINUOUS VENT
LAVATORY
LAVATORY
WET VENT 2 IN.
3 IN. FLOOR DRAIN
BATHTUB
WET VENT (3 IN.)

Figure 4:12 Wet Vent Length Not Restricted

The length of a wet vent is not limited - Clause 7.5.2.1.(1)(k)


CONTINUOUS VENT
LAVATORY
BATHTUB
WC
LENGTH NOT RESTRICTED

One other condition that is not illustrated above is that the hydraulic load to consider when sizing a continuous vent that serves a wet vent is the hydraulic load that is wet vented. – Clause 7.5.2.1.(1)(g)

EXERCISE 4-7

Read Article 7.5.2.1 and answer the following questions. You have 10 minutes.

1. State the maximum number of water closets that can be wet vented.

____

Code Ref: ______________________________

2. Explain how two wet vented water closets are to be installed.

____

____

Code Ref: ______________________________

3. Can a wet vent serve multiple storeys? If so, what are the limitations?

____

____

____

Code Ref: ______________________________________

4. List the advantages and disadvantages of wet venting:

____

____

____

____

____

____

5. Why are there limitations for use of a soil or waste pipe as a wet vent?

____

____

____

STOP

CIRCUIT VENTS

Circuit vents are installed on two or more fixtures that discharge into a horizontal waste branch. Except in the case of a wet vent, rhis vent is always connected above the centre line of the soil pipe, preferably at the top, to cut down the chances of blockage. Circuit venting is a common style of venting, which is typically used to vent a battery of fixtures that are similar in nature.

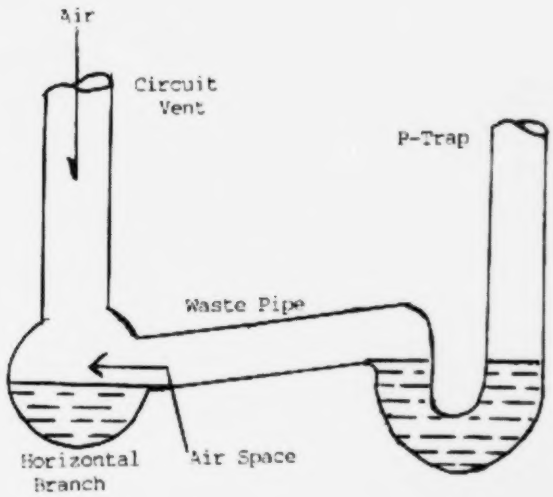
This arrangement is usually found in large buildings where washrooms are able to accommodate large numbers of people. Some examples would be schools, factories, stadiums, large shopping malls, airports, railway stations, etc.

Basically a circuit vent is a form of group venting in which a horizontal branch is vented, instead of each individual fixture having their own vent. If a horizontal branch connected to fixtures is large enough in diameter, there will always be an air space maintained at the top of the branch.

As with all vent pipes (except wet vent pipes) the vent pipe is required to be connected above the horizontal centre line of a nominally horizontal soil or waste pipe. Connecting a circuit vent properly will ensure that atmospheric pressure will always be maintained, thereby preventing siphonage of a trap connected to it.

See Figure 4:13.

Figure 4:13 Circuit Vent Connection



The theory behind this type of vent is summarized below:

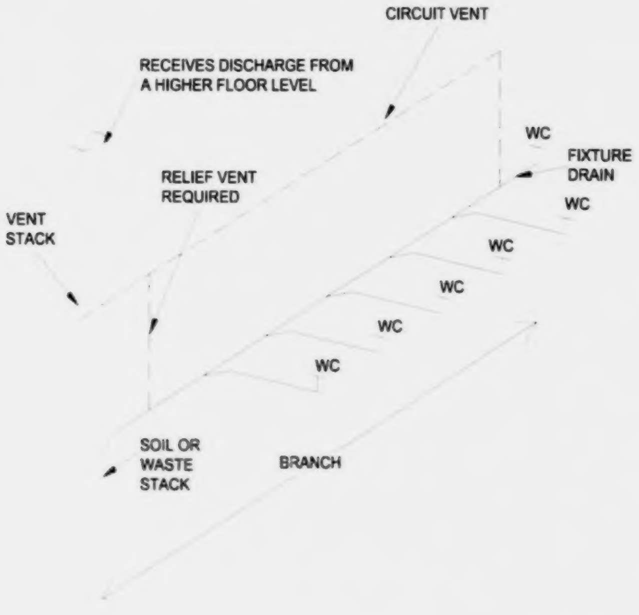
- The horizontal branch is sized as per Section 7.4. so it can adequately drain the fixtures without running full.
- Atmospheric pressure is maintained in the horizontal branch and waste pipes by the connection of vents to the upper part of the horizontal branch.

The advantages of circuit venting are:

- Economy of piping
- Simplicity of installation
- Elimination of numerous dry vents
- Provides free circulation of air through the horizontal branch which it serves.

Figure 4:14 shows a typical circuit vent.

Figure 4:14 Typical Circuit Venting Arrangement


CIRCUIT VENT
RECEIVES DISCHARGE FROM A HIGHER FLOOR LEVEL
WC
FIXTURE DRAIN
RELIEF VENT REQUIRED
WC
VENT STACK
WC
WC
WC
WC
SOIL OR WASTE STACK
BRANCH

CONDITIONS FOR USING CIRCUIT VENTING

There are conditions given in Sentence 7.5.3.1.(1) for when circuit venting can be used to vent a horizontal branch. These conditions are:

- All fixtures served by the circuit vent must be on the same storey.
- The circuit vent must be located at the upstream section of the branch, however, the trap arm of one fixture must be installed upstream of the circuit vent.
- No soil or waste stack can be connected upstream of a circuit vented fixture.
- Fixtures with fixture outlet pipes less than 2 in. in size must be separately vented or separately circuit vented.

The sizing of circuit vents is discussed later in the module.

EXERCISE 4-8

In groups, discuss your experiences with circuit venting and draw an example below and select one member to draw an example on the flip chart.

STOP

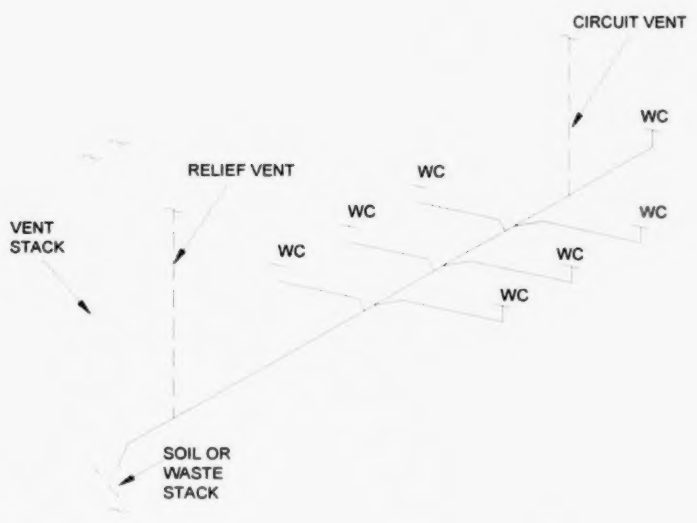
RELIEF VENTS

Generally, circuit venting is used in large buildings containing multiple storeys. A relief vent is required to be used in combination with the circuit vent to relieve pressure that might occur near the front of the branch, which could affect trap seals in that area.

A relief vent provides an additional connection between the drainage system and the venting system. A relief vent is connected to the horizontal drain pipe downstream of the most downstream circuit vented fixture. The relief vent extends up to a vent pipe, which may be a branch vent or a vent stack.

A relief vent is always required when using circuit vent. One option is to provide a dedicated relief vent pipe connected to a vent stack. This is shown in Figure 4:15.

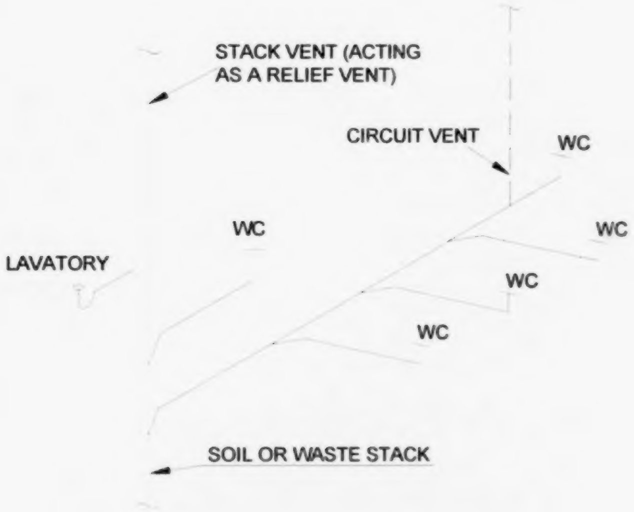
Figure 4:15 Dedicated Relief Vent



Another option is to make a soil or waste pipe act as a relief vent. You can only do this when the pipe has a hydraulic load not greater than 6 fixture units.

This type of situation can include using a separately vented horizontal branch or fixture drain as a relief vent. If the circuit vent is on the top storey of the building, or the stack carries less than 6 fixture units, the soil or waste stack can be used as the relief vent. Figure 4:16 shows this situation.

Figure 4:16 Stack Acting as a Relief Vent

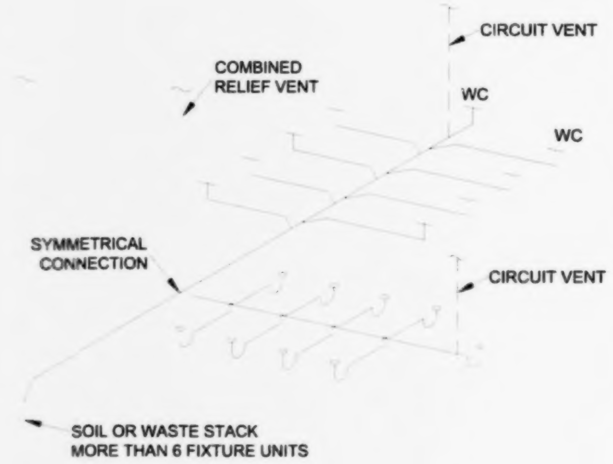

STACK VENT (ACTING AS A RELIEF VENT)
CIRCUIT VENT
WC
WC
WC
LAVATORY
WC
WC
SOIL OR WASTE STACK

Article 7.5.3.1. also permits one relief vent to serve two circuit vented branches. This is called a **combined relief vent**. This can be used when there are not more than 8 circuit vented fixtures connected between the combined relief vent and each circuit vent. The combined relief vent must be symmetrically connected to the circuit vented branch.

Symmetrically connected means using a manufactured fitting that has two or more inlets and connects two or more waste lines to a vent. A combined relief vent is shown in Figure 4:17.

The sizing of relief vents is discussed later in this module.

Figure 4:17 - Combined Relief Vent


CIRCUIT VENT
COMBINED RELIEF VENT
WC
WC
SYMMETRICAL CONNECTION
CIRCUIT VENT
SOIL OR WASTE STACK MORE THAN 6 FIXTURE UNITS

ADDITIONAL CIRCUIT VENTS

Sometimes a circuit vented branch with many fixtures will require more air circulation than can be provided by one circuit vent and one relief vent. Or, the bends on a circuit vented branch will lead to reduced air circulation within the branch.

Additional circuit vents are required in these situations:

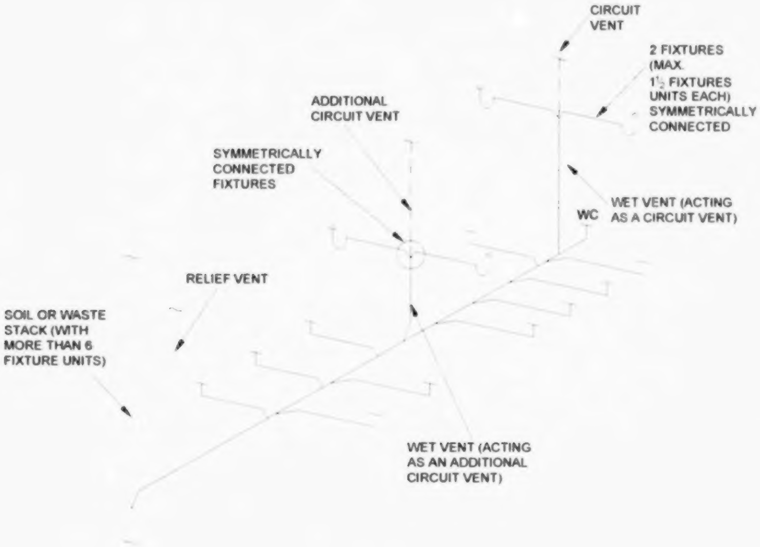
- When there are more than 8 circuit vented fixtures on one circuit vent (between vent pipes), or
- When the cumulative change in direction of the circuit vented branch (between vent pipes) exceeds 45 degrees.

In these situations, additional circuit vents should be provided about halfway between the circuit vent and the relief vent.

One option to provide an additional circuit vent is to provide a dedicated vent pipe connected to a vent stack. Another way to achieve the additional circuit vent function is to use a wet vent in a suitable location, provided it is not less than 2 in. in size and it has been sized as a wet vent.

Read Sentences 7.5.3.1.(6), (7) and (8). These sentences state the requirements for additional circuit vents. One more requirement we have not yet looked at is in Sentence (8) – if the additional circuit vent has fixtures connected to it, (and is therefore a wet vent), the connection must be by means of a double sanitary T fitting.

Figure 4:18 - Additional Circuit Vent


CIRCUIT VENT
2 FIXTURES (MAX. 1½ FIXTURES UNITS EACH) SYMMETRICALLY CONNECTED
ADDITIONAL CIRCUIT VENT
SYMMETRICALLY CONNECTED FIXTURES
WET VENT (ACTING AS A CIRCUIT VENT)
WC
RELIEF VENT
SOIL OR WASTE STACK (WITH MORE THAN 6 FIXTURE UNITS)
WET VENT (ACTING AS AN ADDITIONAL CIRCUIT VENT)

EXERCISE 4-9

1. In your own words or as per the Code write the following definitions.

a) Circuit vent

____

____

____

Code Ref: ______________________

b) Relief vent

____

____

____

Code Ref:________________________________

c) Additional circuit vent

____

____

____

Code Ref:________________________________

2. Select the correct answer. A circuit vent provides venting for:

   a) one fixture
   b) up to 8 fixtures
   c) a section of a horizontal branch
   d) a soil or waste stack

   Code Ref:________________

3. List the conditions when an **additional circuit vent** is required.

____

____

Code Ref:______________________________________

4. Can a **relief vent** serve more than one circuit vented branch? Under what conditions?

____

____

____

Code Ref:______________________________________

STOP

OFFSET RELIEF VENTS

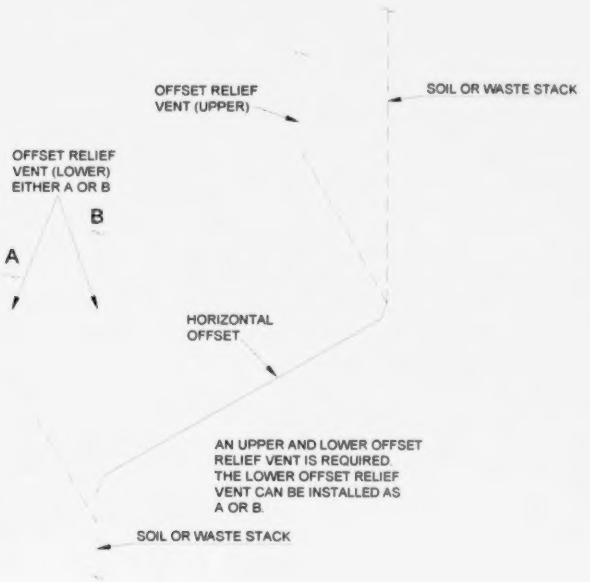
Offset relief vent is a new term in the 2006 OBC. It is used to vent a nominally horizontal offset in a soil or waste stack when the offset is more than 1500 mm long when the stack above the offset serves more than 2 storeys and more than 100 fixture units.

Stacks that serve more than 2 storeys and more than 100 fixture units have a greater probability of carrying high hydraulic load. This might fill most of the stack's cross-sectional area when it flows through the horizontal offset. If it does, it might cause back pressure in the drainage system and this might lead to trap seal failure.

Offset relief vents connected just above the offset and just below the horizontal offset of the stack will prevent the back pressure. The lower offset relief vent can be a vertical extension of the lower section of the stack, or it can be a separate vent pipe that is connected above any other soil or waste pipe connection.

Figure 4:19 below shows the configuration of an **offset relief vent**.

Figure 4:19 - Offset Relief Vent


OFFSET RELIEF VENT (UPPER)
SOIL OR WASTE STACK
OFFSET RELIEF VENT (LOWER) EITHER A OR B
B
A
HORIZONTAL OFFSET
AN UPPER AND LOWER OFFSET RELIEF VENT IS REQUIRED. THE LOWER OFFSET RELIEF VENT CAN BE INSTALLED AS A OR B.
SOIL OR WASTE STACK

EXERCISE 4-10

1. Write the definition for an offset relief vent:

____

____

Code Ref:________________________________

2. A soil stack with a 2 metre offset serves two apartments on each storey in a 5 storey apartment building. Each apartment has a bathroom group, a kitchen sink, and a dishwasher. Does the soil stack require an offset relief vent?

____

____

____

Code Ref:________________________________

STOP

YOKE VENT

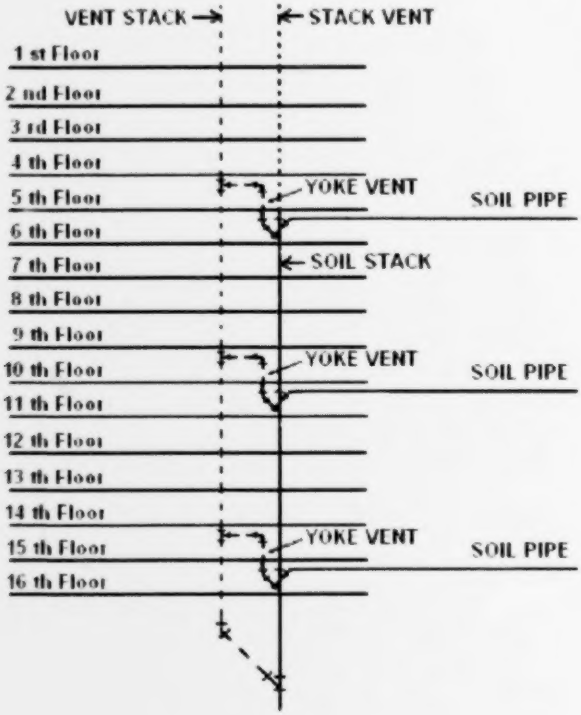
The definition of a **yoke vent** is "a vent pipe that is connected at its lower end to a soil or waste stack and at its upper end to a vent stack or a branch vent that is connected to a vent stack".

The yoke vent is a form of relief venting used in buildings with extreme height. Where plumbing extends through many floors of a building, air pressure builds up ahead of heavy flow and is pushed into branches and waste pipes. By connecting the yoke vent as described above, the build up of pressure is vented through the yoke vent into the vent stack.

A yoke vent is not required if the soil or waste stack is interconnected with the vent stack at each storey, as per Sentence 7.5.4.3.(4)

An example of yoke venting is illustrated in Figure 4:20.

Figure 4:20 - Yoke Venting


VENT STACK
STACK VENT
1 st Floor
2 nd Floor
3 rd Floor
4 th Floor
5 th Floor
YOKE VENT
SOIL PIPE
6 th Floor
7 th Floor
SOIL STACK
8 th Floor
9 th Floor
10 th Floor
YOKE VENT
SOIL PIPE
11 th Floor
12 th Floor
13 th Floor
14 th Floor
15 th Floor
YOKE VENT
SOIL PIPE
16 th Floor

EXERCISE 4-11

1. When is a yoke vent required?

Code Ref:

2. What is the maximum number of storeys permitted in any one section?

Code Ref:

3. When required, describe how a yoke vent would be connected?

Code Ref:

4. Briefly explain the purpose of a yoke vent.

5. What is the minimum number of yoke vents would be required for a stack passing through 24 storeys?

FIXTURES DRAINING INTO VENT PIPES

We already looked at wet vents, where a drainage pipe also functions as a vent pipe. Article 7.5.4.5. permits the trap arm of fixtures to drain into vent pipes, essentially making the vent pipes act as wet vents, subject to these strict conditions:

- maximum 2 fixtures connected to the vent pipe,
- maximum 1 ½ fixture units per fixture,
- the 2 fixtures need to be connected by a double fitting conforming to Table 7.2.4.5., and
- the vent has to meet all wet vent requirements (in Article 7.5.2.1.)

The vents that this applies to are:

- circuit vent
- additional circuit vent
- offset relief vent
- relief vent
- yoke vent

OTHER LOCATIONS THAT VENTS ARE REQUIRED

Special equipment and installations require vent pipes in order to function properly. For example, sanitary sewage sumps require a vent pipe. Subsection 7.5.5. "Miscellaneous Vent Pipes" describes the situations where vent pipes are required.

EXERCISE 4-12

1. Scan through Section 7.5, especially Subsections 7.5.5. and 7.5.7., and for the equipment and/or situations where vent pipes are required. In the table below identify applicable minimum sizes of vent pipes.

Minimum Sizes of Pipes for Equipment
(Subsections 7.5.5. and 7.5.7.)

Equipment	Minimum Vent Size (in.)	Code Reference
Sanitary sewage sumps or tanks		
grease and oil interceptors		
acid waste dilution tank		
corrosive drain piping and dilution tanks		
fresh air inlet for building trap		
manholes within a building		
macerating toilet system sump or tank		

STOP

VENT SIZING

There are three ways to size vent pipes, depending on the type of vent.

1. Based on the largest trap served: **individual vents** and **dual vents** are sized this way.

2. Based on the hydraulic load served: **wet vents, branch vents, headers, continuous vents, circuit vents, stack vents** and **vent stacks** are sized this way. Often the maximum length of the vent pipe is also a factor.

3. Based on the size of pipes connected to, and/or the minimum sizes set by the Code: **relief vents, additional circuit vents, yoke vents, offset relief vents, vents for sanitary sewage sumps** or **tanks, dilution tanks, interceptors, manholes,** and **macerating toilets sumps** or **tanks** are sized this way.

When sizing a vent pipe, always remember to check that you still satisfy the minimum size set by the Code for that type of vent pipe.

Minimum sizes of vent pipes are in Subsection 7.5.7.

The vent pipe sizes in Table 7.5.7.1. that are based on the size of trap served take precedence over all other venting tables.

INDIVIDUAL AND DUAL VENTS

Article 7.5.8.2. states that individual and dual vents are sized based on the size of the largest trap served using Table 7.5.7.1. Individual and dual vents will range from 1 ¼ in. size to 2 in. size. The length of the vent is not taken into consideration in sizing individual or dual vents. Please note that the minimum size of a vent pipe is 1 ¼ in.

Table 7.5.7.1.
Minimum Permitted Size of Vent Pipe and Maximum Trap Arm Based on Size of Trap

Size of Trap Served (inches)	Minimum Size of Vent Pipe (inches)	Maximum Trap Arm (m)
1 ¼	1 ¼	1.5
1 ½	1 ¼	1.5
2	1 ½	1.5
3	1 ½	1.8
4	1 ½	3.0
5	2	4.0
6	2	5.0
Column 1	2	3

You will also need to consult **Table 7.4.9.3.** to determine the **minimum size of fixture outlet pipes**. You may wish to copy this table from your code and keep it handy for all vent sizing exercises.

EXERCISE 4-13

Size the following vent pipes.

1. An individual vent serving a domestic clothes washer.

2. A vent serving a water closet.

3. An individual vent serving a 2 in. floor drain.

Code Ref:

STOP

SIZING BY HYDRAULIC LOAD

Branch vents, headers, continuous vents, circuit vents, vent stacks and **stack vents** are sized based on two factors:

- The **hydraulic load** served by the vent, and
- The **maximum length** of vent pipe.

The hydraulic load served by the vent is determined in the same way as you determined it for sizing drainage pipes – from Table 7.4.9.3. which lists hydraulic loads for various fixtures.

To determine the **hydraulic load**, add the fixture units of the fixtures served by the vent. For example, if a branch vent serves a laundry tray, a lavatory (1 ¼ in. trap) and a kitchen sink, it will serve a hydraulic load of 1 ½ + 1 + 1 ½ = 4.

The hydraulic load for **vent stacks** and **stack vents** is the load drained to the lowest section of the soil or waste stack served by the vent pipe, plus any hydraulic load from any fixture draining directly to the vent pipe.

DEVELOPED LENGTH

The next factor to consider is the length of the vent pipe. The term **developed length** is used in the Code which simply means the centreline length of the pipe and fittings.

Articles 7.5.8.3.and 7.5.8.4. tell you how the length of different vent pipes is measured.

EXERCISE 4-14

Read Articles 7.5.8.3. and 7.5.8.4. and fill in the chart below.

Developed Length for Sizing Vents
(Articles 7.5.8.3. and 7.5.8.4.)

Type of Vent	Developed Length Measured	
	From…	To…
Branch Vent		
Continuous Vent		
Header		
Circuit Vent		
Vent Stack		
Stack Vent		

STOP

EXERCISE 4-15

Read Articles 7.5.8.2. and 7.5.8.5. and answer the questions below.

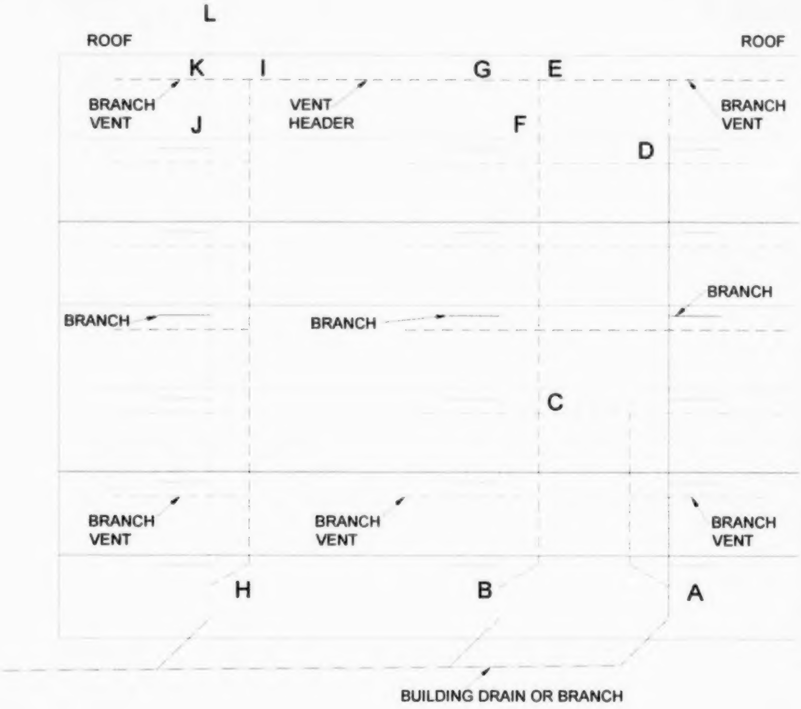
1. Length is not taken into consideration when sizing what types of vent pipes?

2. What do you think the reason is for this?

3. Fill in the Table below with information from Figure 4:21. The row for vent A-C has been completed as an example.

Vent	Type of Vent	Length to be considered
A-C	Vent Stack	ACEGIKL
B-C	Vent Stack	
H-I	Vent Stack	
D-E	Stack Vent	
F-G	Stack Vent	
J-K	Stack Vent	
CEGIKL	Vent Header of any section of it	

Figure 4:21 Developed Length Exercise


L
ROOF
ROOF
K
I
G
E
BRANCH VENT
VENT HEADER
BRANCH VENT
J
F
D
BRANCH
BRANCH
BRANCH
C
BRANCH VENT
BRANCH VENT
BRANCH VENT
H
B
A
BUILDING DRAIN OR BRANCH

STOP

SIZING BRANCH VENTS, HEADERS, CONTINUOUS VENTS AND CIRCUIT VENTS

Use Table 7.5.8.3. to size these vents using the **total hydraulic load** served by the vent and the **length** of the vent pipe.

You may wonder why the table only has numbers in certain rows. This is because the smaller vent sizes are not permitted for large hydraulic loads, and also because large vent sizes have no limit of length for the specific hydraulic loads.

Note that Sentence 7.5.7.2.(1) requires that certain vent pipes be not less than the size of the vent pipe to which it is connected. This is important to remember when sizing continuous vents since they also often serve as individual and dual vents .

EXERCISE 4-16

Size the following vent pipes.

1. A 6 metre long **branch vent** serving 9 fixture units from a combination of 1 ¼ in. and 1 ½ in. vents.

____

____

Code Ref: ______________________________

2. A 10 metre long **circuit vent** serving 48 fixture units and connected to a 4 inch horizontal drainage pipe.

____

____

Code Ref: ______________________________

3. A 30 metre long **header** serving a total of 90 fixture units from a combination of 1 ½ in., 2 in. and 3 in. vent pipes.

____

____

Code Ref:____________________________________

4. A 12 metre long **continuous vent** serving a commercial type dishwasher.

____

____

Code Ref:____________________________________

STOP

SIZING VENT STACKS AND STACK VENTS

As we learned above, vent stacks and stack vents are sized based on length and hydraulic load. Table 7.5.8.4. is used specifically for these vents. To use the table, find a vent pipe size that satisfies both the hydraulic load and the length. Column 3 shows the "Water Occupied Area" for reference purposes only, such as for planning future expansion.

Vent stacks and a stack vents need to be **at least one-half the size** of the soil or waste stack at its base. If you look at Table 7.5.8.4., there are no entries for vent pipes that are less than half the size of the soil or waste stack.

If a stack vent serves a wet vent over 4 storeys high, the stack vent must be the same size as the wet vent as per Sentence 7.5.8.4.(4).

If a vent stack is operating as the vent of the sanitary building drain, it will need to be at least 3 in. as per Sentence 7.5.8.4.(5).

EXERCISE 4-17

Size the following vent pipes.

1. A 12 metre long stack vent that serves a 3 inch soil stack that drains 38 fixture units at its lowest section.

2. A 48 metre long vent stack in a 16 storey building, that serves a 5 in. soil and waste stack with a total hydraulic load of 1248 fixture units.

Code Ref:

STOP

SIZING WET VENTS AND CONTINUOUS VENTS SERVING WET VENTS

You have already been introduced to the concept of a **wet vent** (i.e. a waste pipe that also serves as a vent pipe) and the conditions when wet venting is permitted (see Article 7.5.2.1.). The hydraulic load drained by a wet vent will determine the pipe size.

The following rules apply when calculating the required size of a **wet vent**:

- The hydraulic load of the most downstream fixture is not included.

  (This is because the waste drained from this fixture will not interfere with the venting function of the wet vent since it is downstream.)

- The hydraulic load of separately vented fixtures that drain to the wet vent need to be included.

  (This is because the waste drained from any fixture connected to the wet vent may interfere with the drainage or venting function of the wet vent, even though this other fixture does not require venting through the wet vent itself.)

A **continuous vent** or a **stack vent** that serves a wet vent needs to be sized only for the hydraulic load that is wet vented. This is because a separately vented fixture will need the wet vent for drainage capacity, but not for venting capacity.

If a **wet vent extends more than 4 storeys high**, the stack vent serving the wet vent must be the same size as the wet vent as per Sentence 7.5.8.4.(4). For example, if the wet vent is required to be 4 inches as per Table 7.5.8.1., and it serves more than 4 storeys, the stack vent will also have to be 4 inches.

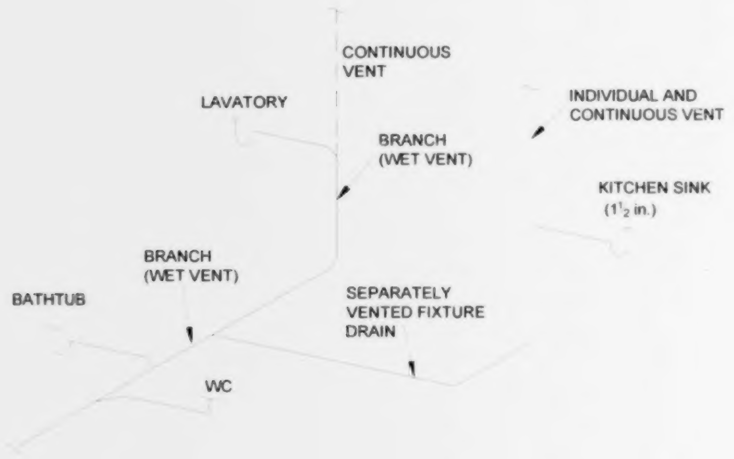
Example of Sizing a Wet Vent and a Continuous Vent Serving a Wet Vent

Figure 10:17 shows a water closet and a bathtub that are wet vented by a lavatory. A separately vented kitchen sink is also drained by the wet vent.

Calculate the size of the wet vent and the continuous vent serving the wet vent. The continuous vent is 3 metres long.

It is recommended that you highlight the sections of the drainage pipes that are used as wet vents.

Figure 4:22 Sizing a Wet Vent and a Continuous Vent


CONTINUOUS
VENT
LAVATORY
INDIVIDUAL AND
CONTINUOUS VENT
BRANCH
(WET VENT)
KITCHEN SINK
(1½ in.)
BRANCH
(WET VENT)
BATHTUB
SEPARATELY
VENTED FIXTURE
DRAIN
WC

Note: Lavatories have 1 1/4 " traps.

Step 1. Determine the hydraulic loads of each fixture.

Find these from Table 7.4.9.3.

Lavatory Basin	1 fixture unit
Kitchen Sink	1.5 fixture units
Bathtub	1.5 fixture units
WC (flush tank)	4 fixture units

Step 2. Determine the hydraulic load carried by the wet vent.

The wet vent does not drain the water closet, so this is not included in the calculation, as per Sentence 7.5.8.1.(2).

Wet vent hydraulic load = lavatory + kitchen sink + bathtub = 4 fixture units

Step 3. Size the wet vent.

From Table 7.5.8.1., the wet vent is serving a water closet, so Column 3 is used. Since the hydraulic load is 4 fixture units, the wet vent pipe size is 3 in. As per 7.5.2.1.(1)(j), the wet vent size needs to be maintained throughout its entire length.

Step 4. Determine the hydraulic load served by the continuous vent.

Use only the hydraulic load that is wet vented as per Clause 7.5.2.1.(1)(g). The kitchen sink is separately vented, and is not included in the calculation.

Continuous vent hydraulic load = lavatory + bathtub + flush tank WC = 6.5 fixture units

But, this can be considered a **bathroom group** in Table 7.4.9.3, with a hydraulic load of 6 fixture units.

Step 5. Size the continuous vent.

From Table 7.5.8.3., a hydraulic load of 6 fixture units and a length of 3 metres will be adequately served by a 1 ¼ in. vent pipe.

However, consider that the wet vent serves a water closet with a 3 in. trap. As per Table 7.5.7.1., a 3 in. size trap requires a minimum vent size of 1 ½ in. Therefore, the continuous vent is required to be 1 ½ in. size.

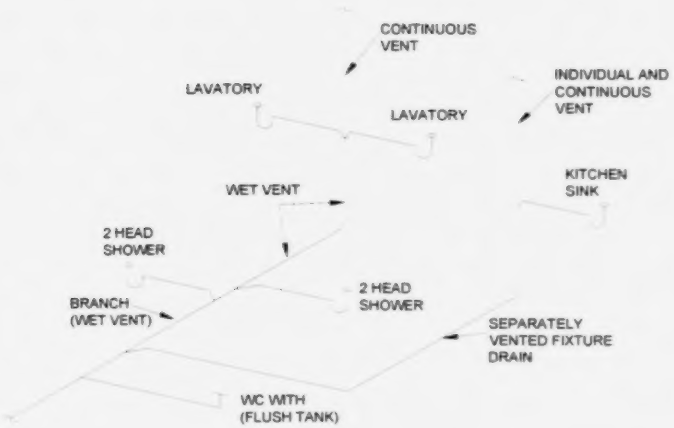
Note that the branch drain downstream of the wet vent is sized based on the hydraulic load served. The lavatory, bathtub and water closet can be considered as a bathroom group for Table 7.4.9.3. Branch hydraulic load = bathroom group + kitchen sink = 7.5 fixture units. The minimum size for this pipe is 3 inches based on Table 7.4.10.8., which matches the minimum drain size serving a water closet of 3 in (7.4.9.2.)

STOP

EXERCISE 4-18

Calculate the size of the wet vent and the continuous vent serving the wet vent in the Figure 4:23. The continuous vent is 4 metres long. The lavatories have 1 ¼ in. traps.

Figure 4:23 Sizing a Wet Vent and Continuous Vent (Ex.4-18)


CONTINUOUS VENT
LAVATORY
INDIVIDUAL AND CONTINUOUS VENT
LAVATORY
KITCHEN SINK
WET VENT
2 HEAD SHOWER
2 HEAD SHOWER
BRANCH (WET VENT)
SEPARATELY VENTED FIXTURE DRAIN
WC WITH (FLUSH TANK)

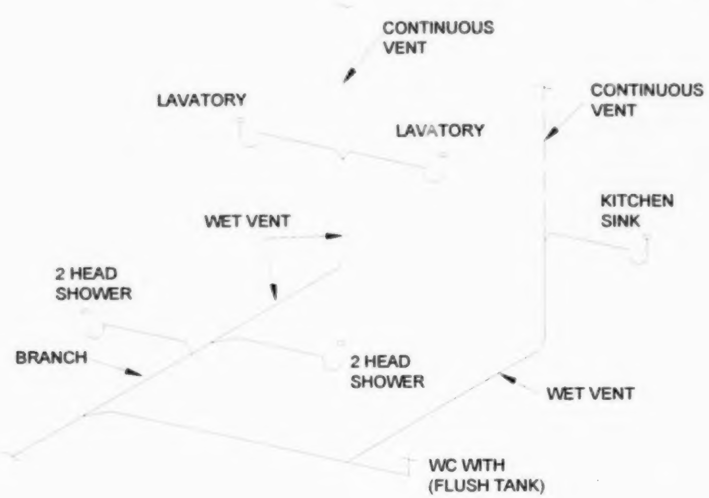
Code Ref:

STOP

EXERCISE 4-19

Calculate the size of the wet vent and the continuous vent serving the wet vent in the Figure 4:24. The continuous vent is 4 metres long. The lavatories have 1 ¼ in. traps.

Figure 4:24 Sizing a Wet Vent and Continuous Vent (Ex.4-19)


CONTINUOUS VENT
LAVATORY
CONTINUOUS VENT
LAVATORY
KITCHEN SINK
WET VENT
2 HEAD SHOWER
BRANCH
2 HEAD SHOWER
WET VENT
WC WITH (FLUSH TANK)

Code Ref: ____________________

STOP

EXERCISE 4-20

We have seen that the method of sizing a vent pipe depends on the type of vent pipe. We have also seen that there are often minimum sizes for certain vent pipes.

Read Section 7.5. and fill in the table on the following page. You can use this table in your work as a quick reference.

Summary of Vent Sizing - 2006 OBC (Section7.5)

Type of Vent	Min. Size	Max. Size	Size Based On				Table	Code References
			Trap Served	Hydraulic Load	Length	Size of Pipe Connected		
Individual Vent								
Dual Vent								
Wet Vent								
Branch Vent								
Continuous Vent								
Header								
Circuit Vent								
Stack Vent								
Vent Stack								
Stack Vent								
Offset Relief Vent								
Relief Vent								
Additional Circuit Vent								
Yoke Vent								
Fresh Air Inlet								
Grease Interceptor								
Oil Interceptor								
Sanitary Sewage Sump/Tank								
Dilution Tanks								
Macerating Toilet Sump/Tank								

FUTURE VENTS

Article 7.5.5.5. has a general requirement that where plumbing is planned for future installations, the sizing of the drainage and venting need to be sized so they can handle the future connections.

There is also a specific requirement that every storey in a building that has plumbing requires a minimum 1 ½ in vent pipe to serve future connections. If a sewage sump or tanks is to be installed the vent pipe needs to be at least 2 in. – Sentence 7.5.7.7.(2)

Unused vent pipes installed for future connections shall be permanently capped with an end cleanout or an adapter and plug – Sentence 7.5.6.2.(3)

You can imagine how useful this requirement is for the person who decides to install a basement washroom in their house many years after construction is finished.

OTHER REQUIREMENTS

This module has concentrated on types of vents, conditions of their use, and sizing of vents. There are additional requirements related to vent installation and testing that you should know.

These requirements are related to:

- Materials
- Joints
- Support
- Drainage of vent pipes
- Vent pipe connections
- Terminals
- Testing
- Air Admittance Valve

MATERIALS, JOINTS AND SUPPORT FOR PIPING

The regulations for materials are covered in Section 7.2.

Subsections 7.2.5., 7.2.6. and 7.2.7. cover non-metallic materials, ferrous materials, and non-ferrous materials and stipulate the standards for certification of pipe, fittings and solvent cement used in a venting system.

Note that some types of materials are not permitted in certain situations. Aluminum is no longer a permitted DWV material in new construction in the 2006 OBC.

Section 7.3. Piping regulates joints used in plumbing systems. Article 7.3.3.4. specifically prohibits running thread and packing nut connections, unions with a gasket seal, and slip joints in venting systems.

Subsection 7.3.4. has requirements for the support of vertical and horizontal piping, and applies to drain and vent pipes.

EXERCISE 4-21

1. What types of copper tubing cannot be used in a venting system?

____

____

Code Ref:________________________________

2. Why do you think that a slip joint cannot be used in a venting system?

____

____

Code Ref:________________________________

3. Much of the venting system takes the form of vertical piping. In anchoring vertical piping, what must you remember?

____

____

Code Ref:______________________________________

4. If the nominally horizontal vent-pipe material you are using is plastic, what is the necessary support interval?

____

____

Code Ref:______________________________________

STOP

VENT PIPE DRAINAGE AND CONNECTIONS

Subsection 7.5.6. states how vent pipes are to be installed. Key requirements are:

- Every vent pipe shall be installed without depression in which moisture can collect – 7.5.6.1.(1).
- Vent pipes are to be as direct as possible to a vent stack or open air – 7.5.6.2.(1)
- Connection to nominally horizontal drainage pipes must be above the horizontal centre line of the drainage pipe 7.5.6.2.(2).
- Every vent pipe must extend above the flood level rim of every fixture it serves before being connected to another vent pipe. (This does not apply to wet vents 7.5.6.4.(1)

EXERCISE 4-22

1. What could happen if Sentence 7.5.6.4.(1) was not met?

____

____

2. What could happen if Sentence 7.5.6.2.(2) was not met?

____

____

3. Why do you think Sentence 7.5.6.2.(1) is a requirement?

____

____

4. Why do you think Sentence 7.5.6.1.(1) is a requirement?

____

____

STOP

VENT TERMINALS AND TESTING

All venting systems must connect to open air, this is referred to as the vent terminal. Article 7.5.6.5. regulates terminal locations since the air coming out of terminals will be sewer gas and minimum distances to open windows, air intakes and neighbouring buildings are required.

Note that vent pipes are required to be installed inside buildings, but exterior vent pipes are permitted for additions of alterations.

Plumbing systems are tested before being put into service. Venting systems can be tested by a water test, air test or final test as per Subsection 7.3.6.

Air tests are not used as often because the test requires more equipment, more time, and the test is sensitive to changes in temperature. The advantage of an air test is that it may be used in freezing conditions where water usage is avoided.

EXERCISE 4-23

Read Article 7.5.6.5. and Subsection 7.3.6. and answer the following questions.

1. Explain when a vent pipe can be installed on the outside of a building and describe how it is to be installed.

Code Ref:

2. What are the minimum clearances from a vent terminal -

   a) to an air inlet, openable window or door?

   Code Ref:

   b) to a roof that supports an occupancy?

   Code Ref:

   c) to the ground?

   Code Ref:

   d) above a roof surface?

   Code Ref:

3. When is a final test required?

Code Ref:

STOP

AIR ADMITTANCE VALVES

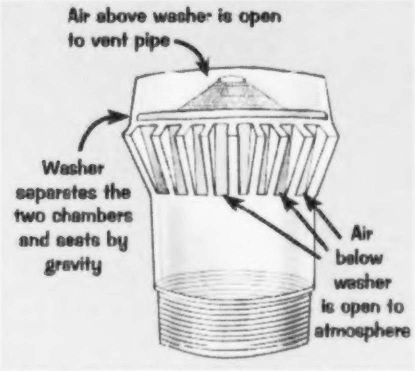
An air admittance valve provides a venting function through a one-way valve designed to allow air to enter the drainage system when the pressure in the plumbing system is less than the atmospheric pressure.

The 2006 OBC **permits air admittance valves** to be used to vent fixtures in **buildings undergoing renovation** and where the **connection to a vent may not be practical.** Both of these conditions are necessary for air admittance valves to be permitted. Air admittance valves cannot be used in new construction.

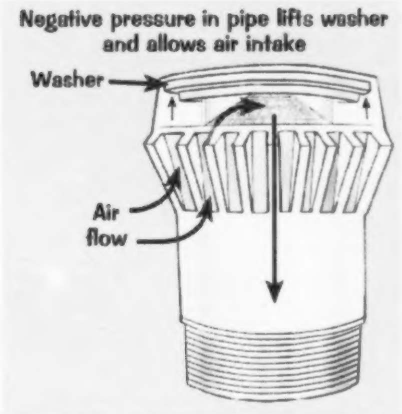
Subsection 7.5.9 sets out additional conditions where air admittance valves can and cannot be used, and requirements for their installation.

Air admittance valves must conform to ASSE 1051, "Individual and Branch Type Air Admittance Valves for Sanitary Drainage Systems" – Sentence 7.2.10.16.(1)

Figure 4:25 Air Admittance Valves


Air above washer is open to vent pipe
Washer separates the two chambers and seats by gravity
Air below washer is open to atmosphere

Air Admittance Valve in Closed Position


Negative pressure in pipe lifts washer and allows air intake
Washer
Air flow

Operation of Air Admittance Valve

STOP

EXERCISE 4-24: VENTING EXERCISE

Take one hour to examine Figure 4:26 and fill in the table with minimum vent sizes. A few lines have been filled in to help get you started.

Assume the following:

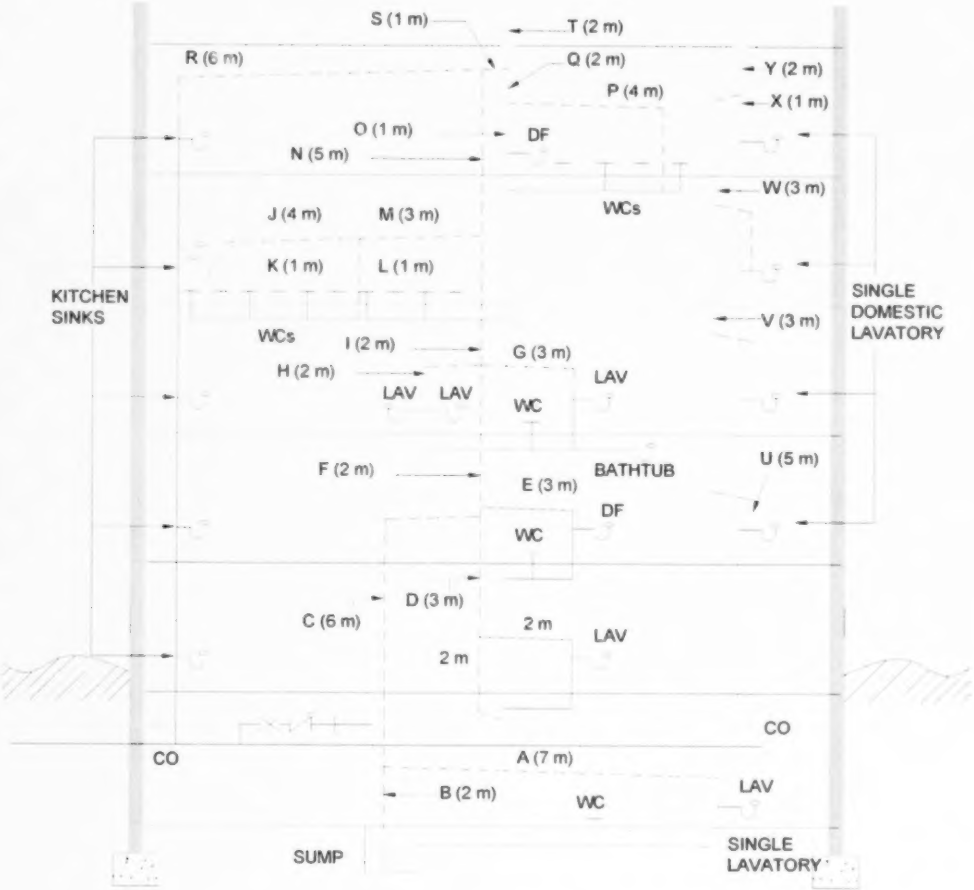
- Lavatories have 1¼" traps
- Building drain slope is 1:100
- All water closets are tank type.

It is recommended that you use the following steps in sizing each vent:

1. Identify the type of vent.
2. Determine the developed length
3. Determine the hydraulic load served.
4. Identify the any minimum size.

Note: The figure is schematic only, fittings are not shown. Vent A is given as an example.

Figure 4:26 Vent Sizing Exercise


S (1 m)
T (2 m)
R (6 m)
Q (2 m)
Y (2 m)
P (4 m)
X (1 m)
O (1 m)
DF
N (5 m)
W (3 m)
WCs
J (4 m)
M (3 m)
K (1 m)
L (1 m)
KITCHEN SINKS
SINGLE DOMESTIC LAVATORY
V (3 m)
WCs
I (2 m)
G (3 m)
H (2 m)
LAV
LAV
LAV
WC
F (2 m)
BATHTUB
U (5 m)
E (3 m)
DF
WC
D (3 m)
C (6 m)
2 m
LAV
2 m
CO
CO
A (7 m)
LAV
B (2 m)
WC
SUMP
SINGLE LAVATORY

Vent Pipe	Vent Name	Developed length used to determine size, m	Hydraulic load used to determine size, fixture units	OBC Code Reference	Minimum size, inches
A	Continuous Vent	A+C=13	5	7.5.7.1.	1½
B					
C					
D					
E					
F					
G					
H					
I					
J					
K					
L					
M					
N					
O					
P					
Q					
R					
S					
T					
U					
V					
W					
X					
Y					

MODULE 4 QUIZ

1. Venting systems are designed to:

   (a) keep pipes from freezing
   (b) protect trap seals in the drainage system
   (c) provide other routes for waste flow
   (d) seal out sewer gases

   Code Ref:______________________

2. Every Sanitary Building drain must terminate at its:

   (a) upstream end in a minimum 4 in. stack
   (b) downstream end in a minimum 3 in. stack
   (c) upstream end in a minimum 3 in. stack
   (d) upstream end in a minimum 2 in. stack

   Code Ref:______________________

3. The minimum size of a vent pipe serving a water closet:

   (a) 1¼
   (b) 1½
   (c) 2
   (d) 3

   Code Ref:______________________

4. The length of a Vent Stack is its developed length from:

   (a) the lowest horizontal branch to a header
   (b) the lowest horizontal branch to open air
   (c) its lower end to a header
   (d) its lower end to open air

   Code Ref:______________________

5. A branch receives the discharge from seven water closets, seven basins, seven stall urinals, one floor drain, and five showers. All are circuit vented except the basins. The following vents are required for the branch:

   (a) relief vent, a circuit vent, two additional circuit vents
   (b) relief vent, a circuit vent, one additional circuit vent
   (c) relief vent, a circuit vent
   (d) three circuit vents

   Code Ref:____________________

6. A relief vent may serve as a wet vent and carry a maximum of:

   (a) one fixture having a maximum of 1½ fixture units
   (b) two fixtures having a maximum of 1½ fixture units each
   (c) one fixture having a maximum of 2 fixture units
   (d) two fixtures having a maximum of 1½ fixture units

   Code Ref:____________________

7. The maximum number of floors permitted in any one section of a yoke vent is:

   (a) 4
   (b) 5
   (c) 7
   (d) 11

   Code Ref:____________________

8. When a Vent Stack is installed in a high-rise building, the maximum number of floors it may pass through is:

   (a) 3
   (b) 11
   (c) 21
   (d) no limit

   Code Ref:____________________

9. Which vents are **NOT** sized based on length:

   (a) individual vents, vent stacks, and relief vents
   (b) dual vents, stack vents, and branch vents
   (c) individual vents, relief vents, vent pipes for interceptors
   (d) dual vents, yoke vents, and stack vents

   Code Ref:________________________

10. The minimum size of vent required for a 4 inch trap is:

   (a) 1 1/4 inch
   (b) 1 1/2 inch
   (c) 2 inch
   (d) 3 inch

   Code Ref:________________________

END OF MODULE

MODULE 5

WATER SUPPLY

PLUMBING – ALL BUILDINGS - 2007

MODULE CONTENTS

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LEARNING OBJECTIVES

Upon completion of this module, participants will be able to:

- Identify Building Code water supply fixture unit requirements for different fixtures and devices
- Recognize head loss in elevation and identify total developed length of piping
- Size water supply piping
- Find other applicable requirements for water supply piping
- Find the objectives of key water supply requirements

INTRODUCTION

In this module, we will learn how to size water distribution pipes for potable water systems.

Sentence 7.6.1.1.(1) states that potable water systems shall be designed, fabricated and installed in accordance with good engineering practice, such as that described in the ASHRAE Guide and Data Books, the ASHRAE Handbooks and ASPE Data Books. ASHRAE stands for American Society of Heating Refrigeration and Air Conditioning Engineers. ASPE stands for American Society of Plumbing Engineers.

More specifically, good engineering practice is described in:

- 2003 ASHRAE Handbook of HVAC Applications, Chapter 45, "Control of Gaseous Indoor Air Contaminants"
- 1999 ASPE Data Book – Volume 2, Chapter 5, "Cold Water Systems"
- 1999 ASPE Data Book – Volume 2, Chapter 6, "Domestic Water Heating Systems Fundamentals"

Alternative procedures are contained in the Appendix A [A-2.6.1.1.(1)] of the National Plumbing Code of Canada.

This module illustrates how to use the NPC sizing method to size a water pipe system.

STOP

DRINKING WATER SYSTEMS

Potable water systems are supplied by **drinking-water systems**, a term that has the same meaning as defined in the Safe Drinking Water Act, 2002:

> "drinking-water system" means a system of works, excluding plumbing, that is established for the purpose of providing users of the system with drinking water and that includes,
>
> (a) any thing used for the collection, production, treatment, storage, supply or distribution of water,
>
> (b) any thing related to the management of residue from the treatment process or the management of the discharge of a substance into the natural environment from the treatment system, and
>
> (c) a well or intake that serves as the source or entry point of raw water supply for the system.

OBJECTIVES AND FUNCTIONAL STATEMENTS

The objectives of the 2006 OBC are set out in Division A, Sentence 2.2.1.1(1). Some key objectives linked to potable water systems and water supply pipe sizing are listed below.

EXERCISE 5-1

Complete the following exercise by filling in the blanks, then discuss your answers with your group. The first objective is completed as an example.

Objective No.	OBC Objective
OH2.2	An objective of this Code is to limit the probability that, as a result of the design or construction of a building, a person in the building will be exposed to an unacceptable risk of illness due to unsanitary conditions caused by consumption of contaminated water.
OS2.3	An objective of this Code is to limit the probability that, as a result of the design or construction of a building, a person in or adjacent to the building will be exposed to an unacceptable risk of injury due to ____________ failure caused by damage to or ____________

	of building elements.
OS3.2	An objective of this Code is to limit the probability that, as a result of the design or construction of a building, a person in or adjacent to the building will be exposed to an unacceptable risk of injury due to ______________ caused by contact with hot surfaces or __________________.
OP5	An objective of this Code is to limit the probability that, as a result of its design or construction, a building will be exposed to unacceptable risk of damage due to ________________ of service water or sewage.
OR1	An objective of this Code is to limit the probability that, as a result of the design or construction of a building, water resources will be exposed to an unacceptable risk of depletion or the capacity of the water supply, treatment and disposal infrastructure will be exposed to an unacceptable risk of being ____________________, caused by the consumption of _______________.

Below are five of the many functional statements that are linked to potable water system requirements.

F31 To minimize the risk of injury to persons as a result of contact with hot surfaces or substances.

F70 To provide potable water.

F71 To provide facilities for personal hygiene.

F72 To provide facilities for the sanitary disposal of human and domestic wastes.

F81 To minimize the risk of malfunction, interference, damage, tampering, lack of use or misuse.

Supplementary Standard SA-1 shows the specific functional statements for each requirement.

STOP

SIZING PROCEDURES

This sizing procedure is based on the National Plumbing Code Appendix A, with reference to OBC requirements and tables where appropriate.

1. Determine Conditions: Three different conditions need to be determined:

1a. Determine Water Supply Fixture Units (wsfu)

The NPC uses wsfu to size water pipe systems. Both the hot and cold wsfu must be determined to size both hot and cold systems. The total number of fixture units served by a section of water supply piping is determined by using OBC Table 7.6.3.1. First find the applicable fixture in Column 1. Then find the hydraulic load in fixture units in Columns 4 or 5 depending on private or public use of the building. You will notice that this table is very similar to the sizing tables for drainage systems.

1b. Determine the overall developed length of the water distribution system.

The total developed length of the piping from property line to the most remote outlet must be known in order to size a water system. Once that developed length has been determined, use Table 1 near the end of this module to determine the applicable pipe capacity. Table 1 is reprinted from the National Plumbing Code.

1c. Determine the pressure range.

Table 1 also requires that you identify the pressure range under which the water system will be working.

To determine water pressures for an actual job you should consult the local water purveyor. Beginning with the available pressure at the public water main, property line, pressure loss through meter or other source of supply, and subtracting 0.434 psi for each foot, or 9.8 kPa for each metre, of difference in elevation between the source of supply and the highest water outlet in the building or on the premises, find the "Pressure Range" group in Table 1.

2. Size the Water Service Pipe

Once you have determined the total wsfu's, the overall developed length of the water system, and the pressure range, you are ready to size the water service pipe from the water main to the building control valve.

3. Size the Cold Water Piping

The next step is to size the cold water distribution piping. To determine this sizing, start at the point most distant from the water meter and still on the water system. Then work back toward the meter.

4. Size the Hot Water Piping

Follow a similar process to size the hot water piping system. However, instead of starting with the most distant connection and working back to the meter, work back to the water heater to determine pipe sizing.

STOP

PIPE SIZING WORKING EXAMPLE

Size the water supply piping for a four unit apartment building as shown in Figures 5:1 and 5:2, and illustrate the applicable fixture units for the cold and hot water supply piping for this building.

Blank figures are provided for fixture units and pipe sizes for your use. Figures showing the correct units and sizes are provided for reference on pages following the blank figures.

Each apartment has a kitchen sink, a flush tank water closet, a lavatory and a bathtub. The water heater and a laundry room with one service sink and two automatic clothes washers are located in the basement of this apartment building.

Given:
The overall developed length is 59 feet (18 m).
The elevation head difference is 12 feet (3.65 m).
The available pressure at meter is 60 PSI (413 kPa).

1. Determine Conditions

1a. Determine Water Supply Fixture Units (wsfu)

The water supply fixture unit (wsfu) demand for the entire building is calculated by using Column 4 of Table 7.6.3.1. for private use since this is an apartment building.

Complete the charts following to determine the wsfu.

Illustrate the loading of the cold and hot water supply fixture units for each fixture and each section of water supply piping in Figures 5:1 and 5:2 respectively.

Figure 5:1 Cold Supply Fixture Units

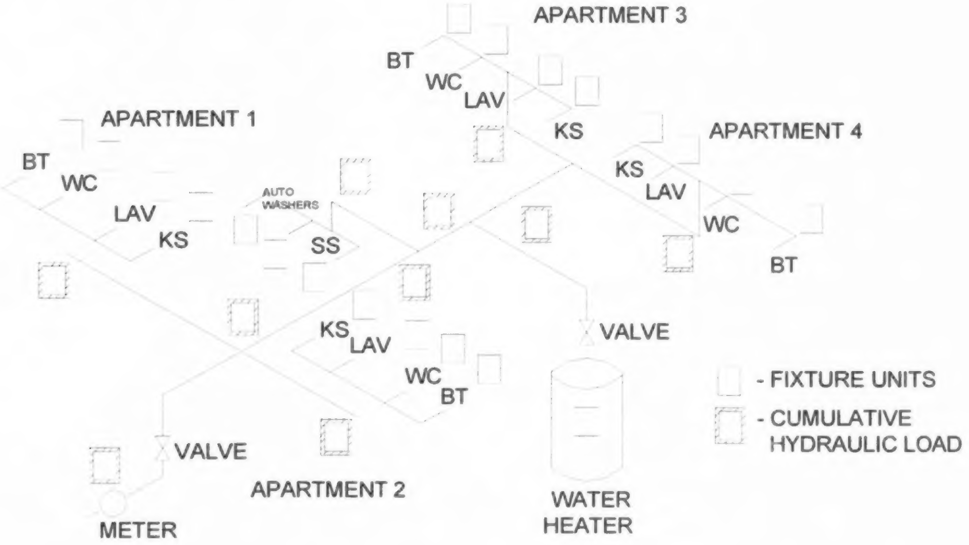
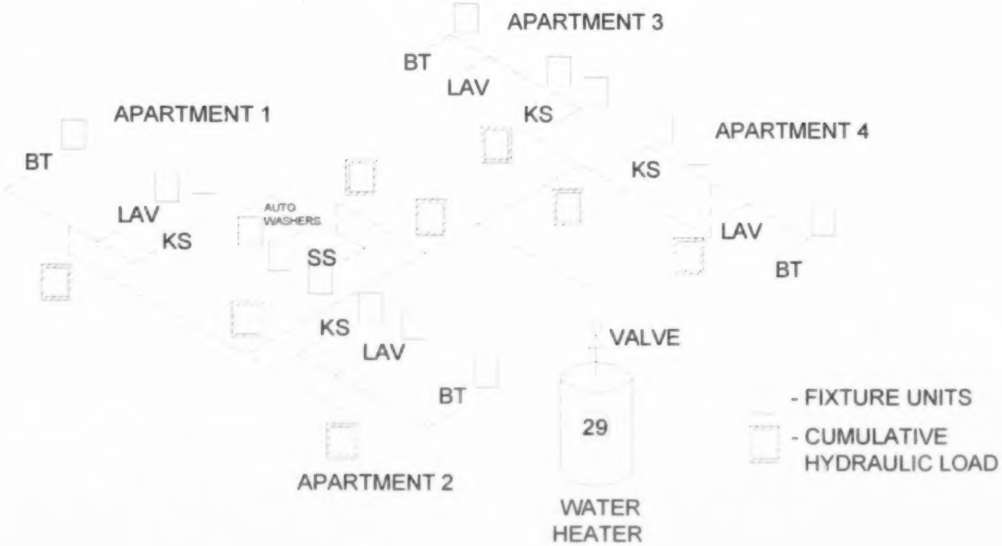

APARTMENT 3
BT
WC
LAV
KS
APARTMENT 1
BT
WC
LAV
KS
AUTO WASHERS
SS
APARTMENT 4
KS
LAV
WC
BT
KS
LAV
WC
BT
VALVE
VALVE
METER
APARTMENT 2
WATER HEATER
- FIXTURE UNITS
- CUMULATIVE HYDRAULIC LOAD

Figure 5:2 Hot Supply Fixture Units


APARTMENT 3
BT
LAV
KS
APARTMENT 1
BT
LAV
KS
AUTO WASHERS
SS
APARTMENT 4
KS
LAV
BT
KS
LAV
BT
VALVE
29
APARTMENT 2
WATER HEATER
- FIXTURE UNITS
- CUMULATIVE HYDRAULIC LOAD

Fixtures within each apartment:	Cold (cwsfu)	Hot (hwsfu)
1 kitchen sink	2	2
1 water closet	3	0
1 lavatory	1	1
1 bathtub	2	2
Total wsfu within each apartment	8	5

Fixtures not within apartments: (Except hot water tank)	Cold (cwsfu)	Hot (hwsfu)
1 service sink	3	3
2 auto clothes washer	2x3	2x3
Total wsfu not within apartments	9	9

Water demand serving the entire building	Cold (cwsfu)	Hot (hwsfu)
Total cwsfu for fixtures	4x8 +9 = 41	
Total hwsfu for fixtures		4x5 +9 = 29
Total wsfu for the entire building	41 + 29 = 70	

Figures 5:3 and 5:4 illustrate the fixture units.

1b. Determine the overall developed length of the water distribution system.

The overall developed length is given as 59 feet (18 m).

1c. Determine the pressure range.

The elevation head difference is given as 12 feet (3.65 m).

0.434 PSI/feet x 12 feet = 5.21 PSI, or
9.8 kPa/m x 3.65 m = 35.8 kPa

Figure 5:3 Cold Supply Fixture Units Answers

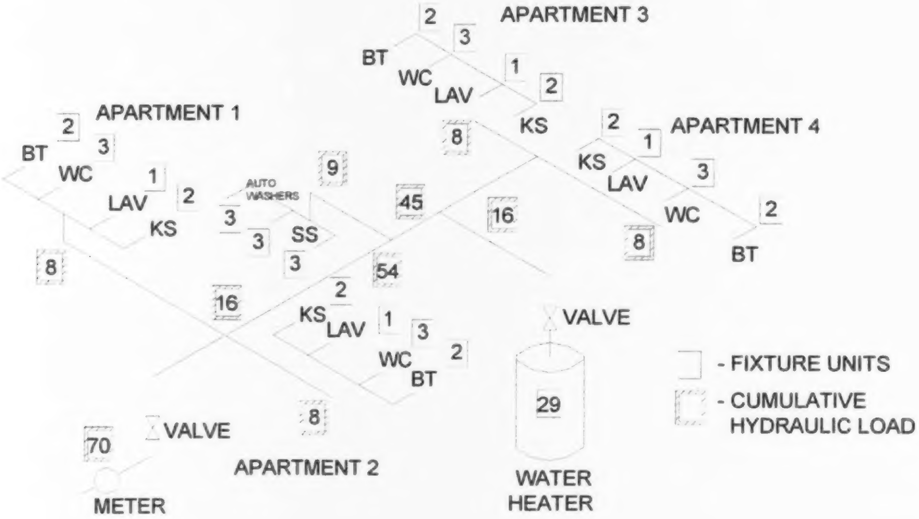
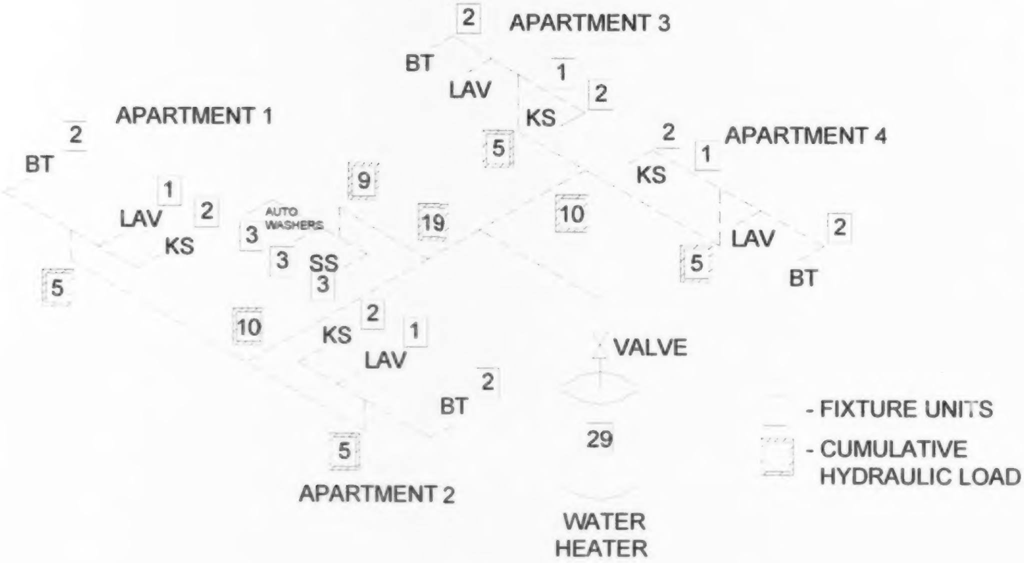

APARTMENT 3
2
3
BT
WC
LAV
1
2
KS
8
APARTMENT 1
2
3
BT
WC
1
LAV
2
KS
AUTO WASHERS
3
3
SS
3
9
45
16
APARTMENT 4
2
1
KS
LAV
3
WC
2
8
BT
8
54
16
2
KS
LAV
1
3
WC
2
BT
VALVE
29
- FIXTURE UNITS
- CUMULATIVE HYDRAULIC LOAD
8
70
VALVE
METER
APARTMENT 2
WATER HEATER

Figure 5:4 Hot Supply Fixture Units Answers


2
APARTMENT 3
BT
LAV
1
2
KS
APARTMENT 1
2
BT
5
APARTMENT 4
2
1
KS
1
LAV
2
KS
AUTO WASHERS
3
3
SS
3
9
19
10
LAV
2
5
BT
5
10
KS
2
1
LAV
2
BT
VALVE
29
- FIXTURE UNITS
- CUMULATIVE HYDRAULIC LOAD
5
APARTMENT 2
WATER HEATER

The available pressure at the meter is given as 60 PSI (413 kPa).

Then, 60 PSI (413 kPa) - 5.21 PSI (35.8 kPa)
= 54.79 PSI (377 kPa)

Therefore, the water distribution piping in this building will be sized from the 311 kPa to 413 kPa (46 PSI to 60 PSI) pressure range in Table 1.

2. Size the Water Service Pipe

The water piping for this entire building will be sized from the 18 m column of the 311 kPa to 413 kPa (46 to 60 PSI) pressure range portion in Table 1.

The size of the water service pipe is determined to be 1". This is because the total water supply fixture unit (wsfu) value serving the entire building is 70. Looking at the column of total developed length of 18 m in Table 1, it can be seen that a 1" water service pipe can supply up to 87 wsfu.

Note that Sentence 7.6.3.4.(1) requires a minimum ¾ inch size for a water service pipe.

Illustrate the minimum required size of the cold and hot water supply piping serving the entire building shown in Figures 5:5 and 5:6 respectively when completing the Steps 3 and 4 below.

3. Size the Cold Water Piping

Since the fixtures in apartment 3 are most remote from the water service pipe, the sizing will begin in apartment 3 and proceed back toward the water service pipe. Using Table 1, with a demand of 8 cwsfu on the pipe supplying the cold water to apartment 3, it is sized as ⅝" pipe.

Figure 5:5 Cold Supply Pipe Sizes

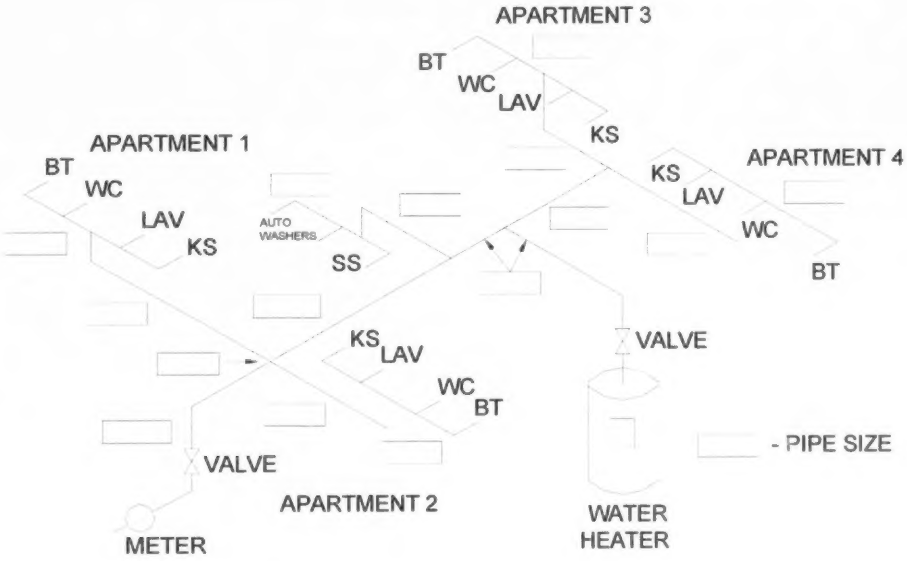
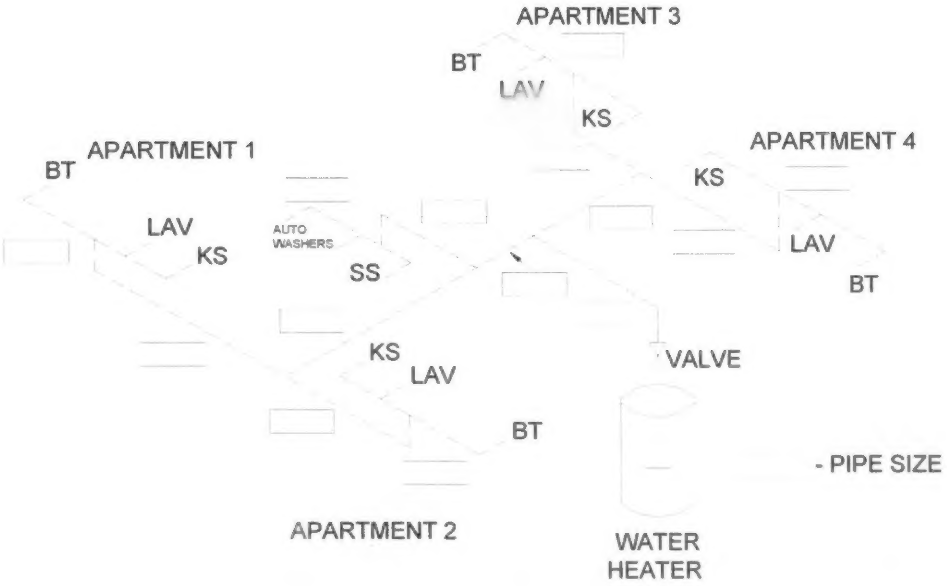

APARTMENT 3
BT
WC
LAV
KS
APARTMENT 1
BT
WC
LAV
KS
AUTO WASHERS
SS
APARTMENT 4
KS
LAV
WC
BT
KS
LAV
WC
BT
VALVE
VALVE
APARTMENT 2
METER
WATER HEATER
- PIPE SIZE

Figure 5:6 Hot Supply Pipe Sizes


APARTMENT 3
BT
LAV
KS
APARTMENT 1
BT
LAV
KS
AUTO WASHERS
SS
APARTMENT 4
KS
LAV
BT
KS
LAV
BT
VALVE
- PIPE SIZE
APARTMENT 2
WATER HEATER

The water supply piping for individual fixtures in apartment 3 are to be sized in accordance with Table 7.6.3.1. The sizing of the cold water piping of the other apartments is identical to that of apartment 3.

At the point where the apartment 3 cold water supply joins the apartment 4 supply, the pipe serves a demand of 16 cwsfu. The pipe must increase in size to a ¾" pipe since this is able to supply 16 to 23 cwsfu.

Continuing back toward the water meter, the next connection is the hot water tank connection. The hot water supply fixture unit (hwsfu) demand of the water heater is 29 as calculated earlier. This connection requires a 1" cold water supply line and can serve up to 47 cwsfu.

A 5/8" line will adequately serve the 9 cwsfu demand of the service sink and two automatic clothes washers located in the basement laundry room.

At the point where the cold water supply to the one service sink and the two automatic clothes washers is taken from the cold water main, the cold water supply fixture unit demand increases to 54 cwsfu. This increase will require a change in the cold water main from 1" up to 1¼". The main will remain 1¼" all the way back to the water meter.

Figure 5:7 Cold Supply Pipe Sizes Answers

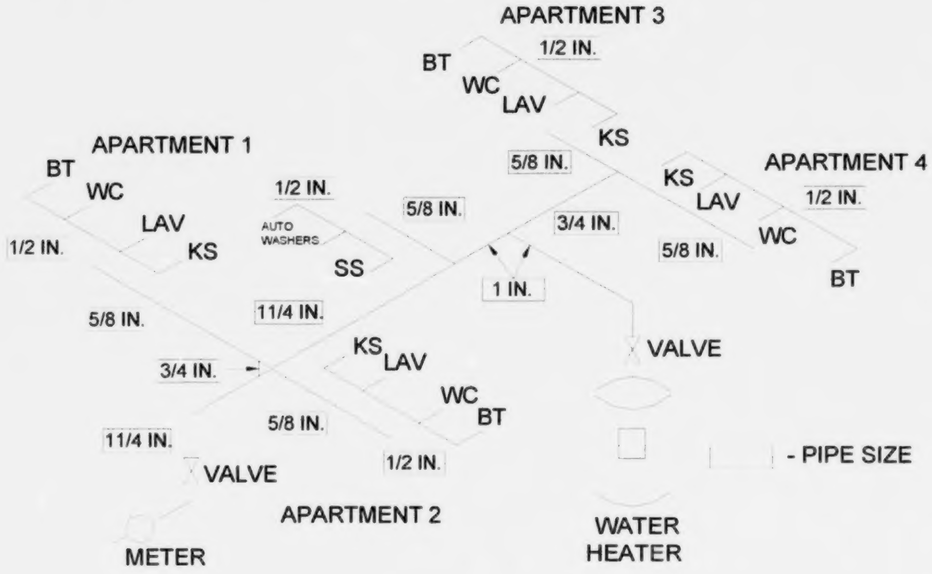
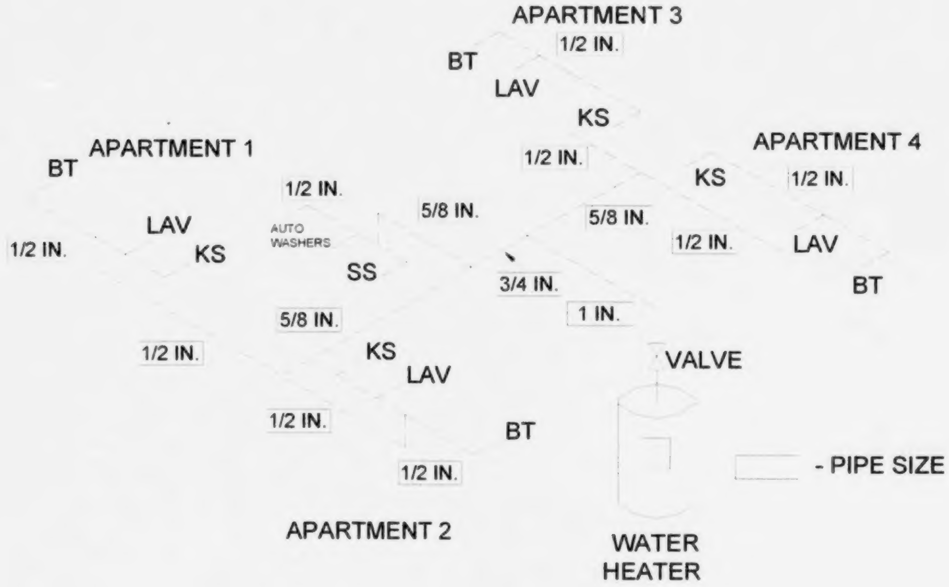

APARTMENT 3
1/2 IN.
BT
WC
LAV
KS
5/8 IN.
APARTMENT 1
BT
WC
1/2 IN.
5/8 IN.
LAV
AUTO WASHERS
1/2 IN.
KS
SS
3/4 IN.
KS
LAV
APARTMENT 4
1/2 IN.
WC
5/8 IN.
BT
1 IN.
11/4 IN.
5/8 IN.
3/4 IN.
KS
LAV
WC
BT
VALVE
5/8 IN.
11/4 IN.
1/2 IN.
VALVE
- PIPE SIZE
APARTMENT 2
METER
WATER HEATER

Figure 5:8 Hot Supply Pipe Sizes Answers


APARTMENT 3
1/2 IN.
BT
LAV
KS
APARTMENT 1
BT
1/2 IN.
APARTMENT 4
KS
1/2 IN.
1/2 IN.
5/8 IN.
5/8 IN.
LAV
AUTO WASHERS
1/2 IN.
KS
1/2 IN.
LAV
SS
3/4 IN.
BT
5/8 IN.
1 IN.
1/2 IN.
KS
LAV
VALVE
1/2 IN.
BT
1/2 IN.
- PIPE SIZE
APARTMENT 2
WATER HEATER

4. Size the Hot Water Piping

Sizing the hot water distribution piping begins in apartment 1 because such an apartment is most remote from the water heater. A ½" branch pipe will adequately serve the 3 fixtures with 5 hwsfu in this apartment that require a hot water supply. A ½" line also serves the other three apartments' hot water needs as well.

At the point where the hot water supply to apartments 1 and 2 joins the hot water main, the piping is increased to ⅝" because of 10 hwsfu. A ¾" pipe is required to supply the combined 19 hwsfu demand by adding the basement laundry room which demands only 9 hwsfu with a ⅝" branch pipe.

The sizing of the hot water supply to apartments 3 and 4 is identical to that for apartments 1 and 2. However, the hot water supply piping from the hot water tank is required to increase to 1" in order to support a total hwsfu demand of 29. At this point the entire hot and cold water distribution piping system has been sized for the 4 unit apartment building plus the basement laundry room.

Figures 5:7 and 5:8 illustrate the pipe sizes.

Table 1 below has been reproduced and modified for this module from the National Plumbing Code of Canada 2005 (NPC).

STOP

Table 1: Pipe Size Based On The Number Of Fixtures Units Served (1)

(from Table A-2.6.1.1.(1) in the 2005 National Plumbing Code)

Water Service, Inches	Water Distribution, Inches	Maximum Allowable Length - Metres								
		12	18	24	30	46	61	76	91	122
Pressure Range 200 to 310 kPa (30 to 45 PSI)		Number of Fixture Units Served								
¾"	½"	6	5	4	3	2	1	1	1	0
¾"	⅝"	12	10	9	7	5	3	3	3	2
¾"	¾"	18	16	14	12	9	6	5	5	4
1"	1"	29	25	23	21	17	15	13	12	10
1"	1"	36	31	27	25	20	17	15	13	12
1¼"	1¼"	54	47	42	38	32	28	25	23	19
1½"	1¼"	90	68	57	48	38	32	28	25	21
1½"	1½"	151	124	105	91	70	57	49	45	36
2"	1½"	210	162	132	110	80	64	53	46	38
2"	2"	220	205	190	176	155	138	127	120	104
2"	2"	372	329	292	265	217	185	164	147	124
2½"	2½"	445	418	390	370	330	300	280	265	240
311 to 413 kPa (46 to 60 PSI)										
¾"	½"	9	7	6	5	4	3	2	2	1
¾"	⅝"	18	15	12	11	9	7	5	5	3
¾"	¾"	27	23	19	17	14	11	9	8	6
1"	1"	44	40	36	33	28	23	21	19	17
1"	1"	60	47	41	36	30	25	23	20	18
1¼"	1¼"	102	87	76	67	52	44	39	36	30
1½"	1¼"	156	130	106	89	66	52	44	39	33
1½"	1½"	270	225	193	167	128	105	90	70	62
2"	1½"	286	266	242	204	150	117	98	84	67
2"	2"	360	350	340	318	272	240	220	118	107
2"	2"	570	510	470	430	368	318	280	250	205
2½"	2½"	680	640	610	580	535	500	470	440	400

Water Service Inches	Water Distribution Inches	Maximum Allowable Length - Metres								
		12	18	24	30	46	61	76	91	122
Pressure Range Over 413 kPa (60 PSI)		Number of Fixture Units Served								
¾"	½"	11	9	7	6	5	4	3	3	2
¾"	⅝"	21	18	15	14	11	8	7	6	5
¾"	¾"	31	28	24	22	18	13	11	10	8
1"	1"	63	53	47	42	35	30	27	24	21
1"	1"	72	66	55	48	38	32	29	26	22
1¼"	1¼"	140	126	108	96	74	62	53	47	39
1½"	1¼"	156	152	150	127	93	74	62	54	43
1½"	1½"	286	286	273	240	186	154	130	113	88
2"	1½"	286	286	286	275	220	170	142	122	98
2"	2"	360	360	360	360	360	335	305	282	244
2"	2"	611	611	610	560	478	420	375	340	288
2½"	2½"	690	690	690	690	690	650	610	570	510
Column 1	2	3	4	5	6	7	8	9	10	11

(1) Note to Table 1: Branch pipes up to 7 m developed length (from main to outlet or fixture) may supply maximum of 4 fixture units for half-inch size and maximum 16 fixture units for three-quarter inch nominal size.

WATER HAMMER ARRESTERS

The use of air chambers made from a piece of capped vertical pipe continues to be acceptable to mitigate-over pressurization of water distribution systems. Article 7.2.10.15 requires the installation of factory built water hammer arresters in accordance with ASSE 1010 "Water Hammer Arresters". By installing pre-manufactured water hammer arresters, the likelihood of failure or rupture of water distribution systems will be reduced.

REQUIREMENTS OF WATER SUPPLY PIPING

Read Articles 7.3.4.9., 7.3.5.7., Subsections 7.1.5., 7.2.11., and 7.6.1. to 7.6.5. and Section 7.7.Complete the following in 20 min.

EXERCISE 5-2

1. Where can the upstream end of a water distribution system connect to and what is the required min. size?

____

____

Code Ref:____

2. In row housing, what types of spaces can plumbing from one unit be installed in when located below other units? Why?

____

____

Code Ref:____

3. Where a private water supply pipe is supplying water to more than one water service pipe, it must be designed and installed in accordance with?

____

____

Code Ref:___________________________________

4. What is the minimum size of a water service pipe, that requires thrust restraint to be provided?

____

____

Code Ref:___________________________________

5. What is the minimum spatial separation requirement between a buried water service pipe and a building sewer if Sentence 7.3.5.7.(2) of the OBC cannot be achieved?

____

____

6. If a copper water service pipe is installed, what is the required Type and Standard it must conform to?

____

____

Code Ref:________________________________

7. Where a potable water system serves a fire sprinkler and/or standpipe system, the connection is required to be protected against what?

____

____

Code Ref:________________________________

8. What 3 criteria are used to determine the type of backflow preventer permitted?

____

____

9. Where a fixture is supplied with separate hot and cold water control, what is the required water control arrangement?

____

____

Code Ref:__________________________________

10. In order to ensure every residential suite can be supplied with water without interruption, what must be installed within each residential suite?

____

____

Code Ref:__________________________________

11. Except for dish and clothes washing machines, what is the maximum allowable hot water temperature supplied to a faucet located in a residential suite?

____

____

12. In what four locations is non-potable water piping prohibited?

13. An outlet from a non-potable water system is prohibited from discharging into what kind of fixtures?

STOP

MODULE 5 QUIZ

1. Where the water supply is to be metered, the installation of the meter, including the piping that is part of the meter installation and the valving arrangement for the meter installation must be:

   (a) provided within each residential building
   (b) installed in accordance with the plumbing inspector's requirements
   (c) installed in accordance with the water purveyor's requirements
   (d) provided within each building

   Code Ref:______________________

2. Which fixture is required to be provided with a shut-off valve on the water supply piping?

   (a) kitchen sink
   (b) lavatory
   (c) laundry tray
   (d) water closet
   Code Ref:______________________

3. Which water supply connection is NOT permitted by the OBC? A water service pipe that connects to a:

   (a) private water supply on the same property
   (b) drinking water system on the same property
   (c) private water supply beyond its property
   (d) municipal drinking water system beyond its property
   Code Ref:______________________

4. A fire service main must be designed, constructed and installed in conformance with the Standard of:

   (a) NFPA 13
   (b) NFPA 14
   (c) NFPA 20
   (d) NFPA 24
   Code Ref:______________________

5. Where copper tubes are being used as water service pipes, they must be certified to the Standard:

(a) ASTM B88 of Type K soft
(b) ASTM B88 of Type M soft
(c) ASTM B68 of Type K soft
(d) ASTM N68 of Type M soft
Code Ref:______________________

6. Where a water service pipe is of 4" or more, thrust blocking cannot be used to restrain:

(a) bends joining two pipes
(b) tee connections
(c) changes of direction
(d) vertical pipes
Code Ref:______________________

7. What is the minimum distance that is required between a private sewage disposal system and a water service pipe with joints?

(a) 1 metre
(b) 3 metres
(c) 10 metres
(d) 15 metres
Code Ref:______________________

8. Tank type water closet valves must be protected against back-siphonage by a preventer which is certified to the following Standard

(a) CAN/CSA B45
(b) CAN/CSA B64.10
(c) CAN/CSA B125
(d) CAN/CSA B137
Code Ref:______________________

9. The maximum flush cycle of a water closet can be more than 13.25 Litres if it serves

(a) an assembly occupancy
(b) a care or detention occupancy
(c) a business and personal services occupancy
(d) an industrial occupancy
Code Ref:________________________

10. Where the hot water supply is controlled by a master thermostatic-mixing valve, the shower valves:

(a) must be pressure-balanced valves
(b) must be thermostatic-mixing valves
(c) must be either pressure-balanced or thermostatic-mixing valves
(d) do not require to be either pressure-balanced or thermostatic-mixing valves
Code Ref:________________________

END OF MODULE

MODULE 6

FITTINGS AND FIXTURES

PLUMBING – ALL BUILDINGS - 2007

MODULE CONTENTS

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T-Y Fittings Used in a Drainage System	6.8
Horizontal to Horizontal Connections	6.8
Vertical to Horizontal Connection	6.10
Horizontal to Vertical Connections	6.11
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Non-Standard Fittings	6.14
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LEARNING OBJECTIVES

Upon completion of this module, participants will be able to:

- Identify Building Code requirements for fittings used on horizontal and vertical piping
- Identify and state where backwater valves are required
- Recognize prohibited and non-standard fittings
- Identify acceptable jointing of dissimilar pipe materials
- Identify where floor drains, fixtures and fixture overflows are required

INTRODUCTION

A well-designed and installed drainage system depends partly on the use of the correct fittings to effect a smooth flow of waste. Certain fittings are permissible in vent piping but not drainage piping, while others are acceptable in vertical but not horizontal piping, etc.

In addition, floor drains and fixture overflows are required to be provided to minimize the impact of potential flooding.

This module discusses some of the most common prohibited fittings and connections, explaining why they are considered to be poor practice.

MATERIALS AND EQUIPMENT

Section 7.2. deals with materials and equipment for plumbing systems. The Subsection titles can help you find your way around, and locate the requirement you are looking for:

EXERCISE 6-1

Scan through Section 7.2. In your own words, write a brief description of what each section covers.

7.2.1. ______________________________

7.2.2. ____

7.2.3. ____

7.2.4. ____

7.2.5. ____

7.2.6. ____

7.2.7. ____

7.2.8. ____

7.2.9. ____

7.2.10. ____

7.2.11. ____

STOP

CERTIFICATION OF MATERIALS

The OBC deals very strictly with plumbing materials and requires that every pipe and every fitting be marked to identify the material, which can include the specifics about the weight, class or size of the product.

If a component of a plumbing system is required to meet a standard, there must be a certification mark on the component, otherwise, the component cannot be considered certified, and is not permitted in a plumbing system. Article 7.2.1.3. describes these requirements.

Plumbing materials and equipment are generally not permitted to be reused. However, if it can be shown that they meet the requirements for new construction, and that they will perform the intended use, plumbing materials and equipment can be reused.

EXERCISE 6-2

Read Article 7.2.1.3 in your Code and answer the following questions.

1. Where in a plumbing system can you install uncertified material?

Code Ref:

Read through the material standards and fill in the required standard for each plumbing material listed below. Include the Code reference:

	Material	Standard
2.	Cast iron drainage and vent pipe and fittings	
3.	ABS floor flanges	
4.	Asbestos-cement drainage pipe and fittings (above ground)	
5.	PVC sewer pipe	
6.	Copper pipe	

7. Mechanical couplings for DWV and sewer pipe

8. Screwed cast iron water fittings

9. Concrete pipe and fittings

10. What action would you take if the installed piping was not Identified?

____

____

____

____

Note: Polybutylene has been removed from Subsection 7.2.5. and Aluminium has been removed from 7.2.6. for use as a piping material.

STOP

NOMINALLY VERTICAL & NOMINALLY HORIZONTAL

Piping in a drainage and venting systems is rarely, if ever, totally horizontal since this would quickly lead to blockages. However, piping is often close to horizontal while maintaining optimum slope for flow, and still being able to run within floor and ceiling assemblies. The term for this in the OBC is "nominally horizontal".

Piping in drainage and venting system is often totally vertical, but may also be installed on an angle to the vertical to accommodate other building features, to reduce the overall length of pipe, or to avoid horizontal sections of piping. The term for this is "nominally vertical".

These terms are used extensively in Part 7.

EXERCISE 6-3

1. Write the definitions from the OBC for:

Nominally horizontal means…____________________________

____

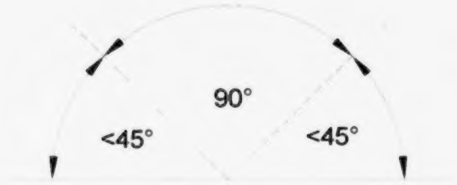
Nominally vertical means... ____________________________

____

Code Ref:____________________________________

2. Indicate on the figure the pipes that are nominally vertical and the pipes that are nominally horizontal.

Figure 6:1 Pipe Orientation



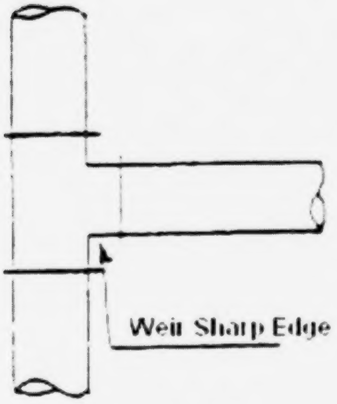
STOP

PROHIBITED FITTINGS AND CONNECTIONS

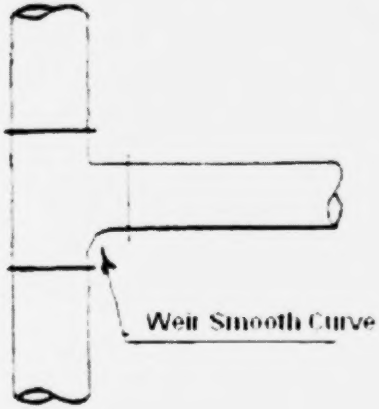
Subsection 7.2.4. deals with pipe fittings. There is only one page in the Ontario Building Code with illustrations, and we can use it now! Table 7.2.4.5. shows the standard types of fittings in DWV systems and summarizes where they are acceptable.

Certain types of fittings are prohibited in specific situations. You can figure out the reason for these rules when you look at the type of fitting and imagine what would happen if the fitting was in service.

Figure 6:2 below shows T Fitting (or "tee" fitting) and a TY fitting (or "tee-wye" fitting). The curvature at the weir on a tee has a sharp edge, as indicated below, but the weir on a tee-wye has a smooth curve.


Weir Sharp Edge

Tee Fitting


Weir Smooth Curve

Tee-Wye Fitting

EXERCISE 6-4

1. What does the OBC say about where a tee fitting can be used? Explain why?

Code Ref:

2. Why is a cross fitting prohibited in a drainage system?

Code Ref:

STOP

T-Y FITTING USED IN A DRAINAGE SYSTEM

Take 30 minutes to read the following and complete Exercises 4 - 10 on your own. When finished discuss your answers with the rest of your group.

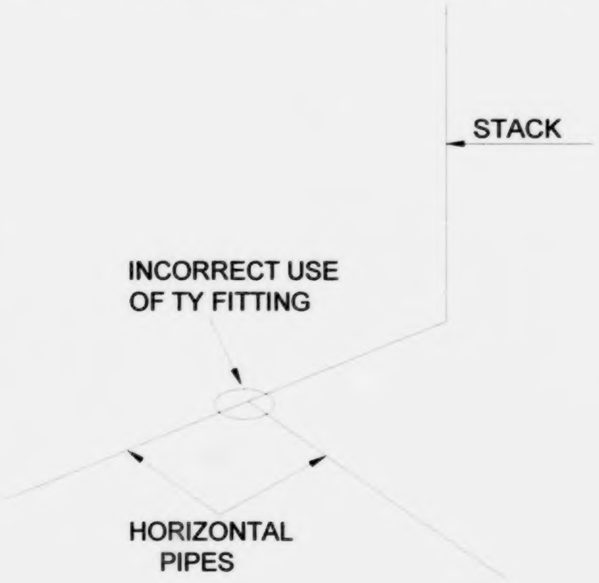
Three drainage layouts you may find using T-Y's are:

1) Horizontal to Horizontal
2) Vertical to Horizontal
3) Horizontal to Vertical

HORIZONTAL TO HORIZONTAL CONNECTIONS

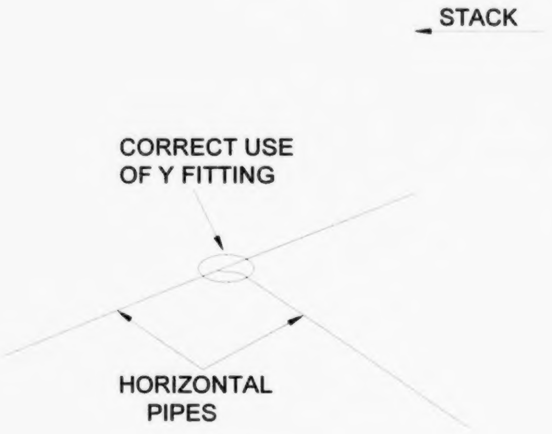
As stated before a well designed system depends on the use of properly installed fittings. Using a T-Y on its side (i.e. for horizontal flow only) does not allow the flow to move with ease. When the flow from one horizontal branch drains into another horizontal branch, the waste will strike the wall opposite of the draining branch and partially rebound back into the branch slowing down the drainage. Also, waste can be forced to drain up stream

Figure 6:3 – Horizontal Connections – TY Fitting NOT Permitted



The proper method of draining horizontal to horizontal is to install a Y fitting and a 1/8 bend (45 degree elbow). This method allows proper deflection of waste material.

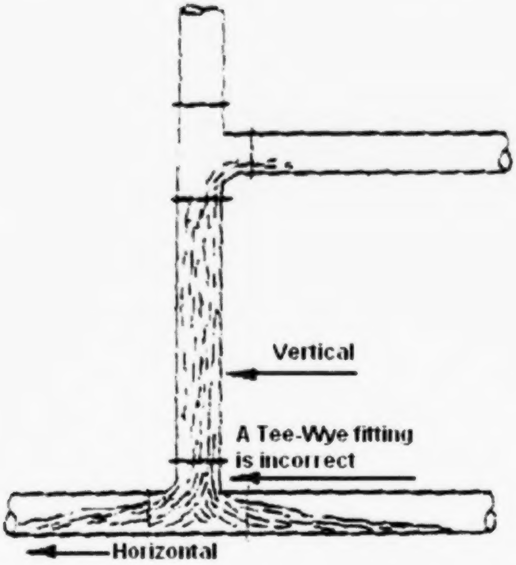
Figure 6:4 Horizontal Connections – Y Fitting Permitted


STACK
CORRECT USE OF Y FITTING
HORIZONTAL PIPES

Remember: ideal flow conditions are those which ensure solid matter is carried downstream with the flow of water.

VERTICAL TO HORIZONTAL CONNECTION

Figure 6:5 - Vertical to Horizontal Connection – TY Fitting NOT Permitted



The reason for not allowing a TY fitting being used in the position above is the same as stated previously, except that the flow of waste upstream on the horizontal branch is greater due to the force of the vertical waste hitting the bottom of the fitting.

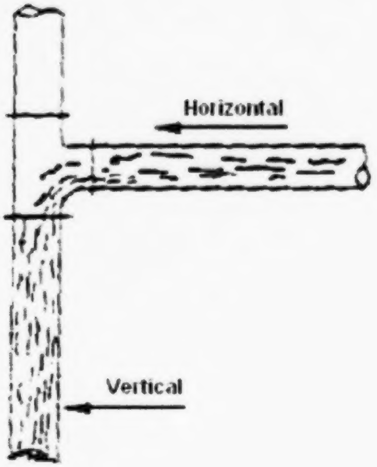
EXERCISE 6-5

Draw the proper method of draining vertical waste into a horizontal branch.

HORIZONTAL TO VERTICAL CONNECTIONS

A TY fitting connecting a horizontal branch into a vertical stack is acceptable as the gravity ensures an effective transition of flow from the horizontal to the vertical.

Figure 6:6 Horizontal to Vertical Connection – TY Fitting Permitted



EXERCISE 6-6

1. State where a double sanitary T-fitting cannot be used to connect back to back fixture drains on a vertical drainage pipe.

Code Ref:

2. Explain where 1/4 bends (90° elbows) are prohibited.

Code Ref:

DOUBLE T-Y

Before moving on it is important that we discuss the difference between a double T or cross fitting and a double TY. The differences between the two is the same as a T and TY.

The cross fitting or double T has a weir with a sharp edge and the double TY has a weir with a smooth edge

Figure 6:7 - Double T-Y Fitting

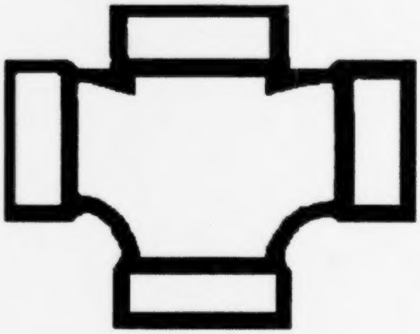


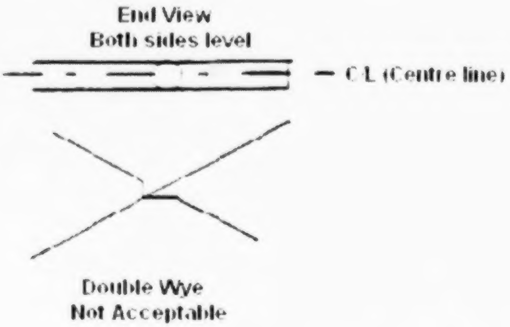
Table 7.2.4.5. states that a Double TY is acceptable only if the vertical run is of 3 inches size or larger and horizontal branches are of 1 ¼, 1 ½ or 2 inches size. This is intended to avoid drainage from one horizontal branch from flowing into another horizontal branch.

A double Y branch is a fitting that is acceptable in nominally vertical but NOT in nominally horizontal piping.

EXERCISE 6-7

1. Take a look at the sketch below and explain why a double Y is not acceptable in horizontal piping.

Figure 6:8 Double Y in Horizontal Piping – NOT Permitted


End View
Both sides level
C-L (Centre line)
Double Wye
Not Acceptable

2. How could you insure proper slope on each branch?

EXERCISE 6-8

Read Subsection 7.2.4. in your code and list six fittings that are not acceptable for use in either vertical or horizontal drainage piping.

Acceptable Fittings for Connecting Drainage Piping
(Subsection 7.2.4.)

Fitting	Vertical	Horizontal
TY-fitting		
T-fitting		
Cross fitting		
Double Y		
Double T-Y		
Double Waste		

EXERCISE 6-9

1. Explain when a T-Y may be used in a nominally horizontal soil or waste pipe.

____

____

____

Code Ref:__________________________________

STOP

NON-STANDARD FITTINGS

As stated in Article 7.2.1.3., every pipe and every fitting installed in a plumbing system shall be certified. Occasionally in a plumbing system we come across some fittings that are non-standard or simply totally new to us. They come about because of different reasons or situations. What is important is that we identify that they are certified by a recognized testing agency.

Certification programs are based on published documents, such as (but not limited to), the CSA standards. Unless a particular product meets the requirements of that standard, the certification mark of the testing agency cannot be applied to it.

For example;
Cast iron pipe and fittings are certified to CAN/CSA-B70-02. CSA would certify cast iron pipe and fittings within the scope of this standard. If a product falls outside the scope of this standard, CSA will not certify it.

EXERCISE 6-10

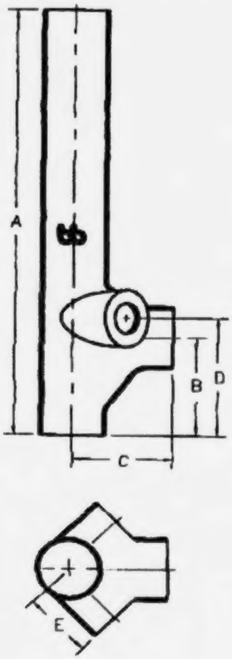
1. Discuss with your group and list any fittings you might find in a plumbing system that are examples of non-standard fittings.

2. Explain what Clause 7.5.2.1.(1)(c) states about connecting fixtures to a stack.

The following fittings are fittings that may not be too common to some inspectors as the type of construction in their area may not justify the use of these non-standard fittings.

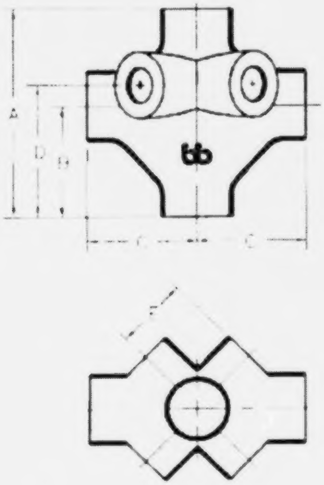
Look over the following fittings and make notes of any questions you may have.

Figure 6:10 TY Special Long Pattern



	CODE	Size	A	B	C	D	E	Weight
in.	5251	3x3x1 1/2 NPT	24	5 7/16	5 1/4	6 1/2	3 11/16	19.0 lbs
mm		75x75x1 1/2 NPT	610	138	133	165	94	8.3 Kg
in.	5252	3x3X2 NPT	24	5 7/16	5 1/4	6 1/2	3 11/16	19.0 lbs
mm		75X75X2 NPT	610	138	133	165	94	8.3 Kg

Figure 6:11 Double TY Special Short Pattern



	CODE	Size	A	B	C	E	Weight
in.	5244	3x3x1 1/2 NPT	10 5/16	5 7/16	5 5/16	3 11/16	17.0 Lbs
mm		75x75x1 1/2 NPT	262	138	135	94	7.7 Kg
in.	5245	3X3X2 NPT	10 5/16	5 7/16	5 5/16	3 11/16	17.0 Lbs
mm		75x75x2 NPT	262	138	135	94	7.7 Kg

STOP

BACKWATER VALVE

The back flow of sewage into homes and businesses is unpleasant, and typically quite expensive. Unfortunately, this sort of personal disaster is all too common. Even more frustrating is the fact that it is unnecessary and easily preventable.

Backflooding of building drains may be caused by any of the following;

1) unusually heavy rain storms
2) overloaded public sewers (sized too small)
3) partially blocked sewers

Backflooding may cause;

1) damage to building contents
2) damage to buildings and drains
3) unsanitary conditions in buildings (health hazard)

A backwater valve means a check valve designed for use in a gravity drainage system which allows fluids to flow only in one direction. In general, the check valve within a backwater valve is designed to be either normally open or normally closed, and they both will be in a close position when backflow occurs.

The 2006 OBC permits a backwater valve to be installed in the normally open position on a building drain if it serves only one dwelling unit, and it is designed according to the appropriate CSA standard listed in Sentence 7.4.6.4.(2).

Where a fixture or branch is located below the level of an adjoining street a backwater valve is permitted on the fixture drain or on a branch serving a number of fixtures on the same storey.

Review the Article 7.4.6.4. and complete the following exercises.

EXERCISE 6-11

1) Explain when a backwater valve may be installed in a building drain or building sewer.

____

____

____

Code Ref: __________________________________

STOP

JOINTING DISSIMILAR PIPE MATERIALS

A plumbing system often contain different types of piping material and they must be designed to accommodate the required transition (i.e. see Article 7.3.3.6.(1). The thing to remember is that all fittings must be certified. The quickest way to confirm certification would be to consult the manufacturer's catalogue. Most manufacturers show the proper installation procedures of the jointing connection for their products.

Below are some common combinations:

- Cast iron to plastic
- Cast iron to threaded steel pipe
- Cast iron to copper
- Cast iron to vitrified clay tile
- Copper to plastic
- ABS to PVC
- Connection to glass or aluminium pipe
- Connection to transite pipe

EXERCISE 6-12

Within your group, list as many different combinations of jointing dissimilar pipe materials as you can think of. Class discussion will start in 5 minutes.

STOP

FIXTURES

Sentences 7.2.2.2.(1)-(8) list the standards to which all fixtures must be in conformance with.

There are miscellaneous requirements related to various fixtures in Part 7 (primarily Sections 7.1 and 7.2), and other Parts of the Code. Module 8 addresses some of these requirements, but see if you can find the requirements that relate to the questions below.

When installing showers in public buildings such as schools, fitness centres, etc., it is common to have more than one shower head. The code makes provisions to accommodate this type of installation in Article 7.2.2.3..

EXERCISE 6-13

1. Explain when a floor drain is required to be provided?

____

____

Code Ref: ______________________________

2. What are the requirements for fixture overflows serving kitchen sinks and lavatories?

____

____

Code Ref: ______________________________

3. What are the accessibility requirements for fixtures and devices?

____

____

____

Code Ref: ______________________________

4. What are the requirements for direct flush valves?

____

____

____

____

Code Ref:____

5. What is the installation requirement of a bubbler orifice serving a drinking fountain?

____

____

Code Ref:____

6. What are the required fixtures to be provided in a dwelling unit and in a recreational camp?

____

____

____

Code Ref:____

7. What are the maximum allowable hot water temperature at the kitchen faucet and shower outlets in a dwelling unit?

____

____

Code Ref:________________________________

8. What is the required hot water temperature range of equipment supplying service hot water in a dwelling unit?

____

____

Code Ref:________________________________

9. Describe 4 required features for showers.

____

____

Code Ref:________________________________

____

____

Code Ref:________________________________

____

____

Code Ref:________________________________

____

____

Code Ref:________________________________

STOP

MACERATING TOILETS

When you renovate your basement to install a new washroom and it is not possible to provide a connection to your building sanitary drain, the 2006 OBC permits a macerating toilet to be installed.

A macerating toilet looks similar to a standard toilet, however, instead of draining the flushed sewage down into the floor, the macerating toilet liquefies the sewage and pumps it through discharge pipes into an acceptable sanitary drain.

Macerating toilets can only be substituted for normal water closets where no connection to a gravity sanitary drainage system is available as per Article 7.4.3.5. The discharge pipe serving a macerating toilet shall not be less than 3/4 in. size, and is considered to have a hydraulic load of 4 fixture units.

Every macerating toilet system for single bathrooms shall conform to CAN/CSA-B45.9, "Macerating Systems and Related Components".

WATER EFFICIENCY

Water efficiency requirements in Subsection 7.6.4 support the Objective OR1 "Resource Conservation – Water Conservation". Water efficiency requirements apply to water supply fittings and plumbing fixtures.

Table 7.6.4.1 has the maximum flow rates at test pressures for lavatory faucets, kitchen faucets, and shower heads. This rating is usually found in the manufacturers information with the fitting.

Water efficiency for water closets and urinals is stated as maximum flush cycles (in litres). Table 7.6.4.2.B applies to water closets and urinals in new construction. The maximum flush cycle of replacement fixtures in buildings existing before January 1, 1996 are permitted to be higher, as per Table 7.6.4.2.A.

Water efficiency requirements do not apply to heritage buildings.

EXERCISE 6-14

1. What is the maximum flow rate for a shower head at the test pressure of 550 kPa?

    a) 8.35 L/min
    b) 9.5 L/min
    c) 550 kPa

    Code Ref: ______________

2. What is the maximum flush cycle in litres for a direct flush urinal in a new building?

    a) 6 L
    b) 5.68 L
    c) 3.8 L
    d) 13.25 L

    Code Ref: ______________

STOP

MODULE 6 QUIZ

1. A well designed and installed drainage system depends partly on the use of:

   (a) certified material
   (b) T fittings at all connections
   (c) Y fittings at all connections
   (d) TY fittings at all connections
   Code Ref: ___________________

2. Nominally Horizontal means at an angle of:

   (a) more than 45^0 with the horizontal
   (b) less than 45^0 with the horizontal
   (c) less than 45^0 with the vertical
   (d) none of the above
   Code Ref: ___________________

3. A double sanitary T fitting may be used where:

   (a) back outlet water closets are installed
   (b) two urinals are installed with a cleanout above the connection
   (c) two urinals are installed without a clean out
   (d) in a venting system only
   Code Ref: ___________________

4. A double wye fitting is acceptable on a:

   (a) vertical *stack*
   (b) horizontal branch
   (c) building drain
   (d) nominally horizontal offset
   Code Ref: ___________________

5. No pipe fitting shall be used where it will reduce flow by more than:

   (a) 10%
   (b) 33%
   (c) 50%
   (d) 65%
   Code Ref: ___________________

6. A floor drain must be provided in a (an):

    (a) basement of a dwelling unit
    (b) kitchen of a dwelling unit
    (c) area where a furnace is installed
    (d) washroom
    Code Ref: ____________________

7. Open front seat of a water closet must be provided in a washroom within a hotel:
    (a) Director office
    (b) residential suite
    (c) meeting room
    (d) employee lunch room
    Code Ref: ____________________

8. Floor flanges cannot be made of material that is:
    (a) plastic
    (b) brass
    (c) cast iron
    (d) polyethylene
    Code Ref: ____________________

9. In a dwelling unit, an adequate supply of service hot water with a temperature range from

    (a) 40 °C to 60 °C
    (b) 45 °C to 60 °C
    (c) 49 °C to 60 °C
    (d) 40 °C to 49 °C
    Code Ref: ____________________

10. Normally closed backwater valves are permitted to be installed on:

    (a) fixture drains
    (b) a horizontal branch
    (c) a building drain
    (d) no drainage piping; backwater valves are not permitted to be normally closed
    Code Ref: ____________________

END OF MODULE

MODULE 7

EQUIPMENT AND DEVICES

PLUMBING – ALL BUILDINGS - 2007

MODULE CONTENTS

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LEARNING OBJECTIVES

Upon completion of this module, participants will be able to:

- Determine the code requirements for special equipment relating to small commercial, industrial and multiple residential applications
- Explain the purpose of plumbing equipment and their functions
- Identify some specialized equipment and their uses (grease and oil interceptors)
- Determine the code requirements for valve location

INTRODUCTION

Plumbing systems include fixtures and appliances in addition of the piping for supply, drainage and venting. This module will cover some common equipment such as interceptors, hot water tanks and valves.

Make sure you understand the difference between a fixture and an appliance.

GREASE INTERCEPTORS

A grease interceptor is a box-like device installed in a drainage system and designed to intercept, retain and break down the grease contained in the liquid waste flowing through it. If large amounts of grease are allowed to discharge into a drainage system, results can be inconvenient and also costly due to blockage in the piping.

From a municipal point of view, excess grease flowing into the public sewers and into the sewage treatment plant tends to increase maintenance costs and create difficulty in effective treatment. Therefore it is best to limit the quantity of grease into the drainage system whenever possible.

Some of the problems resulting from excessive amounts of grease released into a plumbing system include:

1) Sluggish flow:

When hot greasy waste flows into cold piping, some grease will congeal and adhere to the walls of the piping. As grease continues to build up, the bore of the pipe reduces, slowing the rate of flow through it.

2) Blockage:

As grease continues to build up eventually the pipe will completely block requiring maintenance.

3) Inconvenience:

Whenever a plumbing system or part of it is out of order due to blockage or any other matter, the problem becomes an inconvenience particularly in public buildings.

4) Interference with the municipal sewage system:

The municipal sewage system is paid for and maintained at the public's expense. Therefore it would be reasonable to expect that types of establishments which would discharge large amounts of grease be responsible for the installation of the appropriate equipment to limit the amount of grease in order to keep public maintenance costs down.

The average residence does not produce enough grease to warrant a grease interceptor. Following are examples of establishments that do:

- Restaurants and cafeterias
- Hotel kitchens
- Soap factories
- Meat packing plants
- Abattoirs

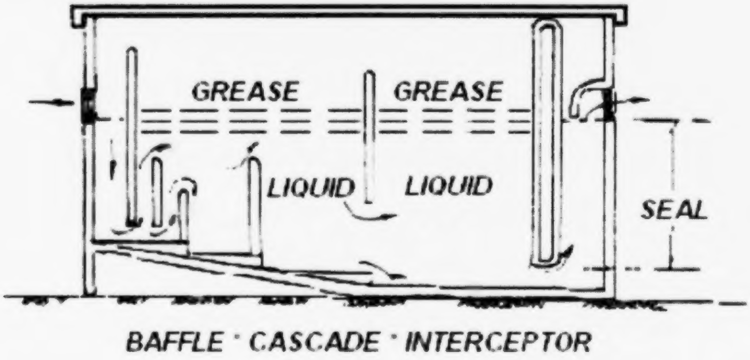
A grease interceptor works because grease and water do not mix. Grease is lighter than water, therefore it will rise to the surface if given the chance.

A grease interceptor is designed to control the rate of flow which is discharged through it which gives the grease time to separate. It also assists in the separation of grease by agitation. Once the grease has been separated the interceptor has the capacity to store the grease until it can be physically removed. All other wastes can pass through the interceptor and travel to a place of disposal.

The efficiency of a grease interceptor is dependent on the proper use and maintenance of the device. If the unit is not maintained at regular intervals it is likely that the grease will plug up the unit and eventually allow grease to pass through into the drainage system.

When grease interceptors are installed they should be located as close as possible to the fixtures they are servicing. If the interceptor is too far away, grease may start to congeal and adhere to the walls of the pipe causing it to clog.

FIGURE 7:1 – Example of a Grease Interceptor



EXERCISE 7-1

Read the following sections and answer the questions by yourself, check your answers with the others when completed.

Articles 7.2.3.2, 7.4.3.3, 7.4.4.3, 7.5.5.2. & Sentence 7.4.7.1.(8)

1. State where a grease interceptor is required.

Code Ref:

2. What known fact makes a grease interceptor work?

3. Describe how a grease interceptor shall be designed.

Code Ref:

4. List any restricted equipment that cannot be connected to a grease interceptor. Explain why.

Code Ref:

5. How must a grease interceptor be vented?

Code Ref:

6. Describe where a clean out for a grease interceptor would be located.

Code Ref:

7. List the advantages of installing a grease interceptor.

8. List the disadvantages of not installing a grease interceptor where large quantities of grease would be discharged into drainage systems.

STOP

All grease interceptors must be sized for any given installation. Choosing the correct size ensures that the interceptor is large enough to intercept and cope with the load to which it will be subjected.

Code Reference - Sentence 7.4.4.3.(8)

"The flow rate through a grease interceptor shall not exceed its rated capacity and the flow rate shall be determined using the following:

$$Q = \left(\sum_{1}^{N}\left(0.75\frac{V}{DDT}\right)\right) + PD$$

Q	is the flow rate to a grease interceptor
V	is the volume of the fixture
DDT	is the drain down time of the fixture in seconds. Part 7 allows for either a 1 or 2 minute drain down time. The longer the drain down time, the smaller the interceptor.
PD	is pumped discharge
N	is the number of fixtures connecting to the grease interceptor
0.75	is the factor that considers that fixtures protected by the grease interceptor are not operated at 100% full capacity all the time

The table following can be used instead of the formula to calculate the flow rate through a grease interceptor. The table calculates the flow rate in litres per second for fixtures with a capacity of 1 through 10,000 Litres. The table includes the 0.75 factor.

Table 7:1 Grease Interceptor Flow Rate (l/s) for 60 seconds Drain Down Time (ddt)

Fixture Volume in Litres	Col. A	Col. B Col. A x 10	Col. C Col. A x 100	Col. D Col. A x 1000
1	0.0125	0.125	1.25	12.5
2	0.025	0.25	2.5	25
3	0.0375	0.375	3.75	37.5
4	0.05	0.5	5	50
5	0.625	0.625	6.25	62.5
6	0.075	0.75	7.5	75
7	0.0875	0.875	8.75	87.5
8	0.1	1	10	100
9	0.1125	1.125	11.25	112.5
10	0.125	1.25	12.5	125

The following examples demonstrate how to calculate the size of a grease interceptor installed in a specific location for specific fixtures.

Example: Calculating the Size of a Grease Interceptor

Calculate the size of a grease interceptor serving a double bowl commercial kitchen sink. Each bowl measures 900 mm x 450 mm x 300 mm.

The following steps should be taken to calculate the grease interceptor size for a one minute drain down:

Step 1: Calculate the capacity of the double compartment sink in cubic millimetres and litres (length x width x depth x the number of bowls).

900 mm x 450 mm x 300 mm = 121,500,000 mm^3 per bowl
= 121.5 litres per bowl

121.5 L x 2 bowls = 243 litres capacity of double compartment sink

Step 2: Convert the total capacity of the sink into litres per second flow.

Using Table 7:1, convert the volume of the sink into a flow rate. Since the table uses increments of 1, 10 and 100, break the volume into these increments to calculate the flow rate:

243 litres = 200 + 40 + 3 litres

200 litres converts to 2.50 litres per second flow +
40 litres converts to 0.50 litre per second flow +
3 litres converts to 0.0375 litres per second flow

Total Flow Rate = 3.0375 litres per second flow

Step 3: To convert back to gallons for interceptor selection you would take the following steps:

- Convert L/s to L/minute by multiplying by 60 seconds/minute
- Convert L/min to Imperial gallons per minute by dividing by 4.5 L/Imperial gallon
- If using US gallons, divide by 3.8

3.0375 L/s x 60 s/min = 182.25 litres per minute flow

182.25 litres per minute divided by 4.5 litres per Imperial gallon

= 40.5 or 40 Imperial gallons per minute flow

Therefore a 40-Imperial gallon interceptor would be able to drain this sink in one minute. A 20 gallon interceptor would be able to drain the sink in two minutes.

Example: Calculating the Size of a Grease Interceptor – Multiple Fixtures

Calculate the size of a grease interceptor serving a small commercial kitchen equipped with a double sink, an exhaust hood and a commercial dishwasher.

In this sizing example the fixtures have the following sizes and /or capacities

- The double commercial kitchen sink is 1000 mm x 500 mm x 400 mm
- The exhaust hood discharges 40 litres per minute
- The commercial dishwasher has a pumped discharge of 46 litres per minute

Double Kitchen Sink

Step 1: Calculate the capacity of the double compartment sink in cubic millimetres and litres (length x width x depth x the number of bowls).

1000 mm x 500 mm x 400 mm= 200,000,000 mm^3; per bowl
= 200.0 litres per bowl
200.0 L x 2 = 400 litres

Step 2: Convert the total capacity of the sink into litres per second flow.

Using Table 7:1, convert the volume of the sink into a flow rate.

400 litres converts to 5.0 litres per second flow

Total Flow Rate for the sink is = 5.0 litres per second flow.

Exhaust Hood

The rating plate on the exhaust hood rates the discharge at 40 litres per minute.

40 L/min ÷ 60 s/min = 0.666 litres per second

Total flow for the hood is = 0.666 litres per second

Dishwasher

The shop drawing of the dishwasher indicates that the pump discharges 46 litres per minute.

46 divided by 60 seconds/minute = 0.76 litres per second discharge

Grease Interceptor Sizing

The total flow in litres per second must be added together at this point:

Double sink = 5.0 litres per second flow
Hood = 0.666 litres per second
Dishwasher = 0.76 litres per second
Total = 6.42 litres per second flow

Step 3: Convert back to gallons for interceptor selection:

6.42 L/s x 60 s/min = 385.2 litres per minute flow

385.2 L/min / 4.5 L/gal = 85.6 Imperial Gallons per minute

It follows from this calculation that an 85 Imperial gallon interceptor would drain these fixtures in a little more than one minute, while a 40 gallon interceptor would drain them in a little more than two minutes.

STOP

OIL INTERCEPTORS

Read through the following information and complete the exercises that follow. Class discussion will start in 30 minutes.

The purpose of an oil interceptor is to retain oil, gasoline and other explosive liquids and prevent their entry into a municipal drainage system, much like a grease interceptor.

Some establishments that use oil interceptors are auto service stations, repair shops, machine shops, refineries, dry-cleaning plants, paint manufacturers and similar plants. The waste materials or spillage from these establishments contain gases or hazardous elements such as gasoline, oil, benzene, naphtha or similar solvents used in manufacturing or servicing.

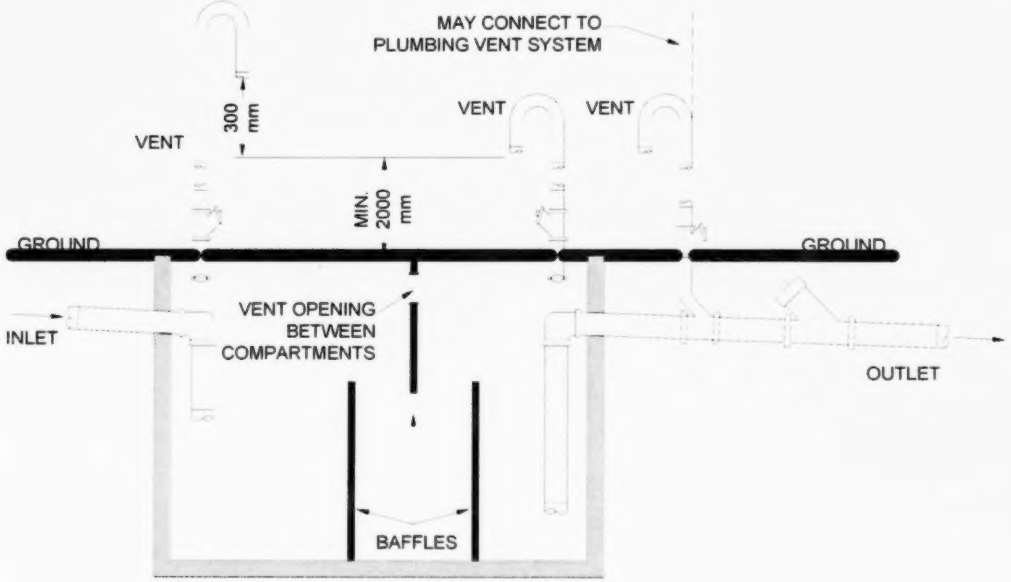
Fire, explosion, pollution of lakes and waterways are only a few of the dangers created by discharge of hazardous chemicals into the drainage system.

Installing the proper size and type of oil interceptor in such buildings listed above provide some positive protection against hazardous chemicals and gases.

The oil interceptor works basically on the same principal as the grease interceptor. They both rely on the separation of the hazardous materials from the water flowing through. The oil interceptor provides a container through which the discharge must pass. The flow is slowed down allowing heavy sand and silt to settle to the bottom and oil, gases and other light density substances to rise to the top where they can be skimmed off.

When oil interceptors are installed it is common that they have three compartments. The three compartments assist in separating waste water from sand, silt, oil and gases. A typical oil interceptor is shown in the diagram following.

FIGURE 7:2 – Example of an Oil Interceptor


MAY CONNECT TO
PLUMBING VENT SYSTEM
VENT
VENT
VENT
300 mm
MIN. 2000 mm
GROUND
GROUND
INLET
VENT OPENING BETWEEN COMPARTMENTS
OUTLET
BAFFLES

As the diagram indicates there are two vents, one at each end of the interceptor. Article 7.5.5.2. of the Code requires every oil interceptor to be provided with two vent pipes that:

a) Connect to the interceptor at opposite ends,
b) Extend independently to open air,
c) Terminate not less than 2 metres above ground and at elevations differing by at least 300 mm, and
d) Do not connect to each other or any other vent pipe.

Also there is a requirement for the adjacent compartments within an oil interceptor to be connected to each other by a vent opening.

These venting requirements will allow the interceptor to have continuous air flow throughout the system. This flow of air allows gases to be removed to the atmosphere, minimizing the danger of explosion.

STOP

EXERCISE 7-2

Read through Articles 7.2.3.2., 7.4.4.3., 7.4.7.1., 7.5.5.2. and 7.5.6.5. and answer the following questions. Discuss your answers with the other members of your group and have someone put the answers on the flip chart.

1. State when an oil interceptor is required. Are there any exceptions?

   ____

   ____

   ____

   ____

   Code Ref: ______________________

2. Explain how you would ensure compliance with Sentence 7.4.4.3.(5).

   ____

   ____

3. Where are clean outs required for an oil interceptor? Are the requirements different for manufactured and built-in-place oil interceptors?

   ____

   ____

   ____

   Code Ref: ______________________

4. Describe how to vent a three compartment oil interceptor that has been built in place with a 4" drain inlet and outlet.

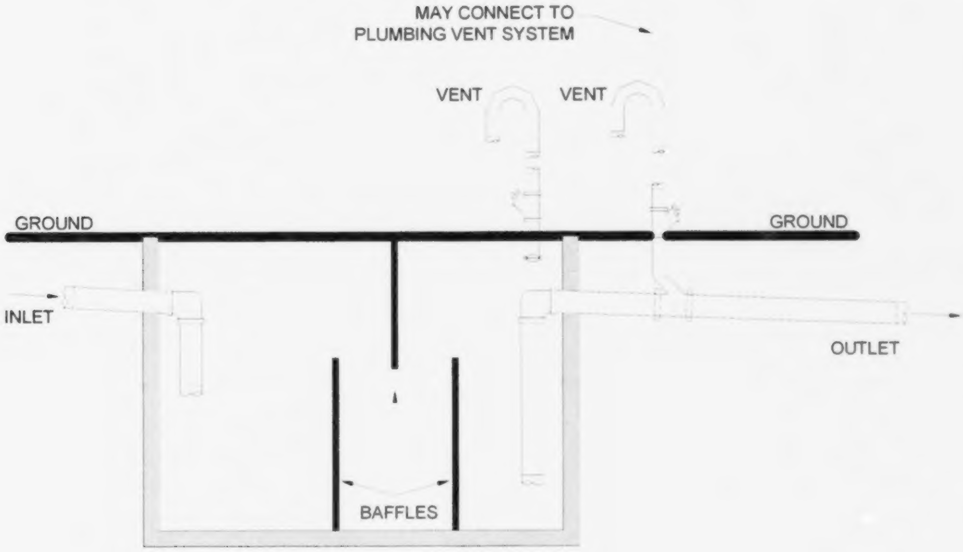
   Code Ref:

5. How do you size the venting for a manufactured oil interceptor where no recommendation has been made?

   Code Ref:

6. Explain why adjacent compartments within an oil interceptor must be connected to each other by a vent as per 7.5.5.2.(2).

7. Examine the drawing below and make any corrections to it.


MAY CONNECT TO
PLUMBING VENT SYSTEM
VENT
VENT
GROUND
GROUND
INLET
OUTLET
BAFFLES

STOP

HOT WATER TANKS

Most residential and light commercial structures have centrally located units that heat and store hot water. These units need piping to bring in cold water and to carry heated water to fixtures that require and discharge hot water.

The most common water heating equipment in use today combines the heating unit with a storage tank. The basic purpose of these units is to automatically provide a supply of hot water at a preset temperature.

The design of the hot water tank takes advantage of water's natural properties. Cold water enters near the bottom of the tank, and as water is heated, it expands. Since expansion makes water lighter, it rises to the top of the tank and hot water is drawn off near the top. Colder, denser water sinks to the bottom of the tank where it is heated. Thus, circulation of water within the tank ensures that a reservoir of hot water will be available at all times. The size of storage tank will depend on the peak demand for water in the building.

Commercial hot water storage systems consist of either a single large hot water storage tank and its associated piping and valves, or a battery of smaller tanks and their piping and valves. These tanks are used to serve the hot water needs of multiple-family dwellings, large public buildings, factories, hotels, office buildings, hospitals, restaurants, etc. they range in size from 80 gallons into the thousands. The purpose of commercial hot water tanks is to store relatively large quantities of hot water to provide adequate supply for heavy demand periods.

TEMPERATURE AND PRESSURE RELIEF VALVES

Every hot water tank shall be equipped with a:

a) pressure relief valve – 7.6.1.12.(1)
b) temperature relief valve – 7.6.1.12.(2)

The temperature and pressure relief valves may be combined as per 7.6.1.12.(3).

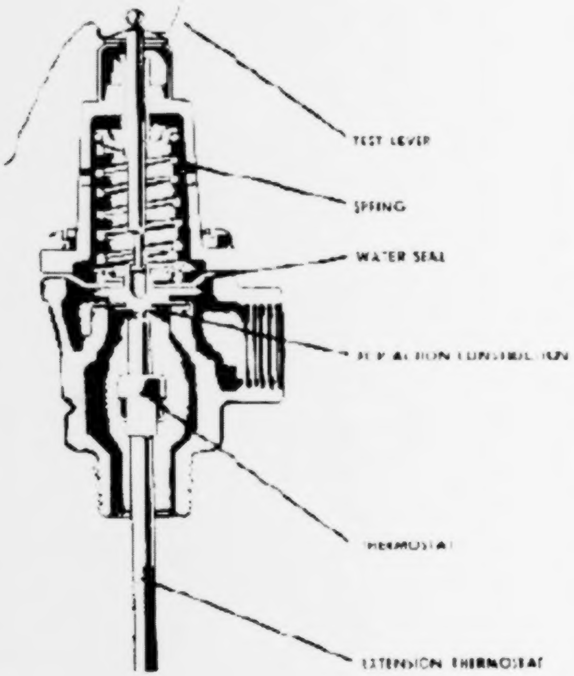
Note that every hot water tank also requires a cold water shut-off valve located close to the tank as per 7.6.1.8.(1).

When a hot water tank or heater is overheated above 99°C, safe conditions can be maintained by replacing hot water with cold. When the tank temperature reaches the danger zone (99°C), the thermostat expands and lifts the valve disc from the seat, allowing hot water to escape and cooler water to replace it in the tank. The valve will reseat itself when the temperature is sufficiently reduced.

If the pressure in the tank exceeds 1100 kPa the relief valve will open and relieve the pressure.

Combined pressure and temperature protection is essential to prevent storage of unsafe high temperature water as well as excessive pressures.

Figure 7:3 Temperature and Pressure Relief Valves


TEST LEVER
SPRING
WATER SEAL
ACTION CONSTRUCTION
THERMOSTAT
EXTENSION THERMOSTAT

EXERCISE 7-3

Read Article 7.6.1.12 in your code and answer the following questions.

1. Describe how to install a temperature relief valve.

Code Ref:

2. Explain when a temperature relief valve and a pressure relief valve may be combined.

Code Ref:

3. State the maximum permissible pressure in a tank.

Code Ref:

4. State the maximum permissible temperature in a tank.

Code Ref:

5. Explain when relief valves are required.

Code Ref:

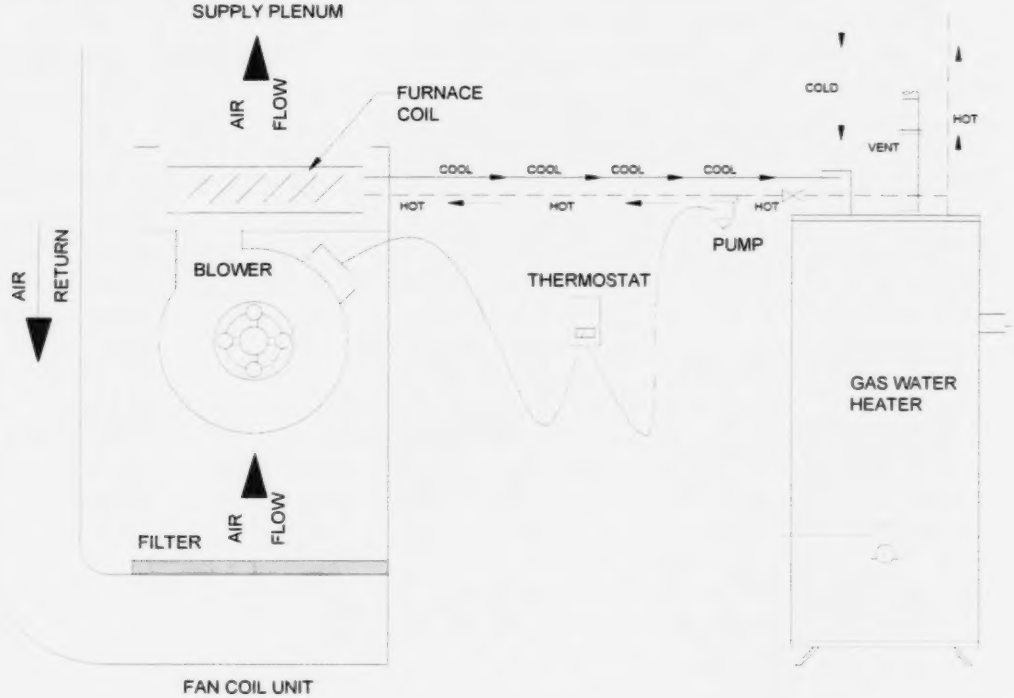
COMBINATION HOT WATER TANKS AND HEATING SYSTEMS

This type of system is common in residential units where a single source of hot water is used for both domestic hot water supply and space heating.

Domestic water is heated inside the tank and circulated to a heating coil at high temperature, usually by means of a circulating pump. A tempering valve is used on the water line that goes out to the plumbing fixtures. The function of the tempering valve is to reduce the hot water temperature to acceptable limits by mixing it with cold water. Gas fired water heaters are typically used in this type of application because of their fast response time compared to electric heaters.

Combination hot water tanks and heating systems are required to be designed in accordance with good engineering practice as per Sentence 7.6.1.1.(1)). Figure 7:4 illustrates the basic operation of a combination hot water tank and heating system.

Figure 7:4 Combination Hot Water Tank and Heating System


SUPPLY PLENUM
AIR FLOW
FURNACE COIL
COLD
HOT
VENT
COOL
COOL
COOL
COOL
HOT
HOT
HOT
PUMP
AIR RETURN
BLOWER
THERMOSTAT
GAS WATER HEATER
AIR FLOW
FILTER
FAN COIL UNIT

TANKLESS/ INSTANTANEOUS HOT WATER HEATERS

Tankless water heaters provide hot water at a preset temperature when needed without storage, thereby reducing or eliminating standby losses.

The tankless heaters can be used either for supplementary heat, such as a booster to a solar hot water system, or to meet all hot water needs.

Tankless water heaters have an electric or gas heating device that is activated by the flow of water. Once activated, the heater provides a constant supply of hot water. The maximum flow rate at a desired temperature will be determined by the capacity of the heater.

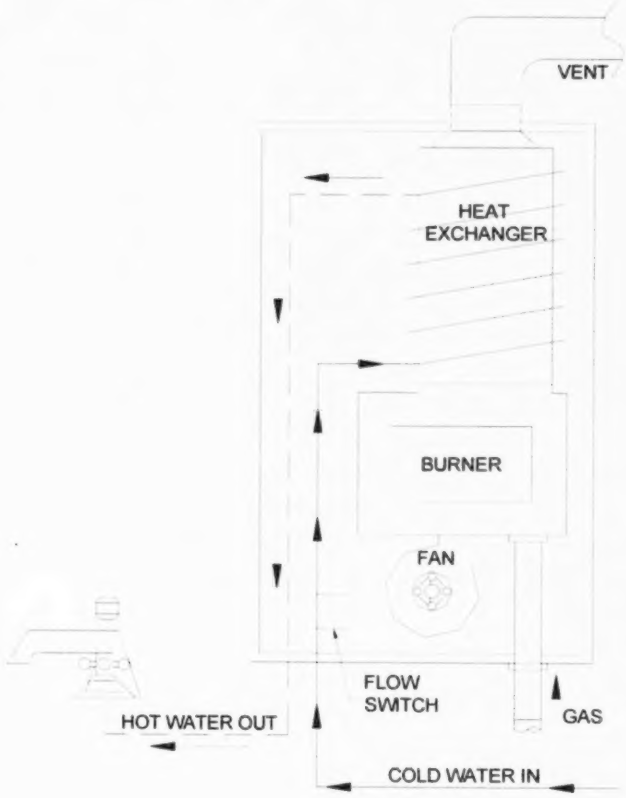
Gas tankless water heaters typically have larger capacities than electric tankless water heaters. Tankless/instantateous hot water heaters are required to be designed in accordance with good engineering practice as per Sentence 7.6.1.1.(1)).

Figure 7:5 illustrates the basic operation of a tankless hot water heater.

A tankless water heater works with the following process:

1. A hot water tap is turned on.
2. Water enters the heater.
3. The water flow sensor detects the water flow.
4. The computer automatically ignites the burner.
5. Water circulates through the heat exchanger.
6. The heat exchanger heats the water to the designated temperature.
7. When the tap is turned off, the unit shuts down.

Figure 7:5 Tankless Hot Water Heater


VENT
HEAT EXCHANGER
BURNER
FAN
FLOW SWITCH
GAS
HOT WATER OUT
COLD WATER IN

STOP

THERMAL EXPANSION

Closed piping systems are created when piping systems have no room for water to expand, such as when backflow preventers are installed. A closed piping system cannot accommodate the increase in pressure caused by thermal expansion.

Article 7.3.3.9. states that the design and installation of every piping system shall, where necessary, include means to accommodate expansion and contraction of the piping system caused by temperature change or building shrinkage.

Protection against thermal expansion is required by Article 7.6.1.16 when any of the following are installed:

- A check valve required by Article 7.6.1.10.
- A backflow preventer required by Article 7.6.2.2.
- A pressure reducing valve require by Article 7.6.3.3.

The methods of accommodating thermal expansion are:

- A thermal expansion relief set at a pressure of no more than 550 kPa (80 psi) and designed for repeated use.

- A suitably sized diaphragm expansion tank designed to be used with potable water.

The expansion tank provides a space into which a noncompressible liquid, such as hot water for domestic heating, can expand or from which it can contract as the liquid's volume undergoes changes with changes in temperature.

To allow for this expansion or contraction, the expansion tank provides an interface point between the system fluid, i.e. heating water, and a compressible gas.

A system designed to function as a closed system can have only one expansion chamber.

Expansion tanks are of three basic configurations:

(1) a closed tank, that contains a captured volume of compressed air and water, with an air water interface (sometimes called a plain steel tank);

(2) an open tank (i.e., a tank open to the atmosphere); and

(3) a diaphragm tank, in which a flexible membrane is inserted between the air and the water (another configuration of a diaphragm tank is the bladder tank).

In the plain steel tank and the open tank, gases can enter the system water through the interface and can adversely affect system performance. For this reason, current design practice normally employs diaphragm tanks.

The following should be taken into considerations when connecting the expansion tank in a closed hot water system:

- A tank open to the atmosphere must be located above the highest point in the system.
- A tank with an air/water interface is generally used with an air control system that continually re-vents the air into the tank. For this reason, it should be connected at a point where air can best be released.
- Within reason, the lower the pressure in a tank, the smaller is the tank. Thus, in a vertical system, the higher the tank is placed, the smaller it can be.

STOP

RECIRCULATING SYSTEMS

Hot water circulating systems circulate hot water through the hot water piping so it is nearly instantaneous to obtain hot water at plumbing fixtures throughout a building.

The types of hot water circulating systems include:

1) Continuously circulating systems:

   This type of hot water circulating systems use a hot water circulating pump to pump hot water from the water heater, through the hot water piping, and on back to the water heater through an additional length of pipe that runs from the furthest fixture back to the water heater.

   This type of hot water circulating system provides nearly instant hot water at the fixtures, but wastes energy through both the energy required to operate the hot water pump and the heat energy lost from the piping.

2) Temperature controlled demand type circulation systems:

Sometimes the circulating pump is controlled by a temperature sensing circuit that shuts off the hot water recirculation pump once the water temperature reaches a pre-set point and starts the pump back up when the water temperature in the pipe drops below a second set point.

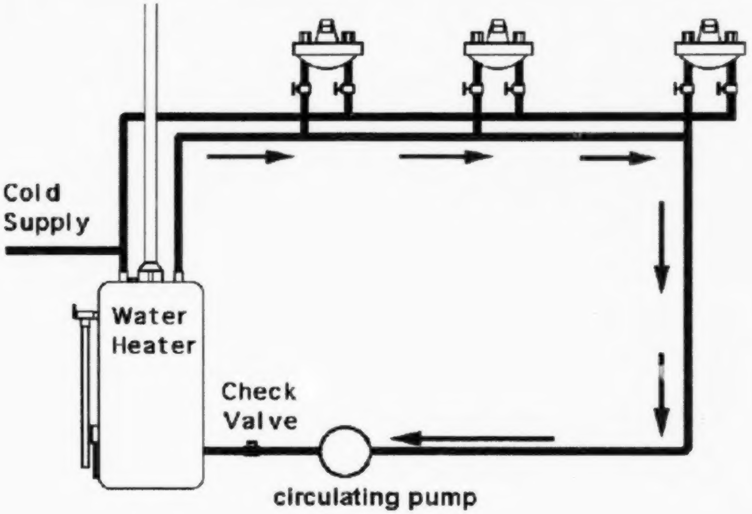
3) A combination of the above systems.

Hot water circulating systems generally provide convenience and save water but at the same time can waste energy and cost the building owner a great deal of money. Figure 7:6 illustrates a traditional type of hot water circulating system.

Recirculation systems are required by Sentence 7.6.1.1.(4) in building that supplies more than 4 storeys, or in a hot water system with a developed length of more than 30 metres.

Figure 7:6

Traditional type hot water circulating system.



CONTROL AND SHUT-OFF VALVES

The following code requirements are small items, but are important and sometimes forgotten.

Control and shut-off valves are required in certain areas within a dwelling unit, i.e., water service pipe entering a building, water closets, outside hose bibs, hot water tanks.

In other types of occupancies, the requirements are the same as dwelling units, in addition there is also the need for shut-offs at other locations. The reason for the location valves in these areas is for maintenance of the fixtures and to ensure that affected suites do not affect other suites or fixtures while repair is necessary.

WATER MIXING VALVES

All valves supplying fixed shower heads are required to be individually pressure-balanced or thermostatic-mixing valves as per Sentence 7.6.5.2.(1). The operation of these valves is indicated below.

Upon use of tempered water, a thermostat in the mixing chamber of the valve senses the outlet temperature. The thermostat automatically positions a seat assembly which controls the flow of hot and cold water supplied to the mixing chamber.

If the mixed outlet temperature increases, the thermostat will expand, moving the seat assembly to allow the cold-water inlet port to open more fully and at the same time restricting the hot water inlet port.

Conversely, if the mixed outlet temperature decreases, the thermostat will contract, moving the seat assembly to allow the hot water inlet port to open more fully and at the same time restricting the cold water inlet port.

In both cases the mixed outlet water temperature is automatically and continually maintained at the preset temperature within the tolerances of the valve. In the event of a cold or hot water supply failure, the seat assembly moves to an extreme position shutting off the hot or cold inlet water port.

A mechanical adjustment permits selection of the desired outlet water temperature within range of the valve. The OBC requires the outlet temperature to not exceed 49 degrees Celsius.

EXERCISE 7-4: Valves

Read Articles 7.6.1.3. to 7.6.1.10. and fill in the chart following to summarize what types of valves are required at the various locations. Briefly describe the required location of the valve, and indicate the code reference.

7.6.1.3. to 7.6.1.10.)

Water service pipe			
Gravity water tank			
Risers (except in single family dwellings			
Water closets			
Suites in a building of residential occupancy			
Each fixture in a washroom for public use			
Tanks			
Plastic water service pipe suitable for cold water use only			

STOP

BACKFLOW PREVENTION

Avoiding the contamination of the potable water supply is a critical issue in the maintenance of health and safety in a community.

Back-siphonage occurs where a vacuum in the water-supply system causes contaminated water to be drawn into the potable water supply. For example, this type of backflow can occur when a hose is left in non-potable water and the municipal pressure drops.

All backflow preventers must be selected, installed & field tested in accordance with the CSA B64.10-01 standard, unless otherwise stated in the OBC. Many municipalities are passing by-laws requiring re-inspection & testing of backflow preventers after they have been installed.

The 2006 OBC has expanded the requirements for backflow prevention from fire protection systems, specifically spelling out the type of backflow preventer required based on the type of system served and the hazard posed by contamination.

Look at Article 7.6.2.4. and Table 7.6.2.4. Factors that need to be known to confirm the type of backflow preventer are: the class of fire protection system, the pipe materials of the system and the use of antifreeze or other additives in the system. The type of backflow preventer installed can be confirmed by its label.

EXERCISE 7-5

Use Articles 7.6.2.4. to answer the following questions.

1. When can a dual check valve type backflow preventer be used?

2. When can a double check valve type backflow preventer be used?

Code Ref: ____________________________________

MODULE 7 QUIZ

1. Grease and oil interceptors work by utilizing the fact that:

   (a) hot water discharge will break down the grease and oil and make it flow
   (b) cold water discharge will make grease and oil congeal and float down the drainage piping
   (c) water does not mix with oil or grease
   (d) interceptors will always be maintained

2. An oil interceptor shall be installed in:

   (a) a public kitchen
   (b) a repair garage
   (c) a restaurant
   (d) all of the above
   Code Ref: ____________________

3. A clean out shall be installed:

   (a) upstream of an interceptor
   (b) downstream of an interceptor
   (c) not required
   (d) both (a) and (b)
   Code Ref: ____________________

4. Every hot water tank must be equipped with:

   (a) a temperature relief valve
   (b) a pressure relief valve
   (c) a device designed to shut off supply of heat source
   (d) both (a) and (b)
   Code Ref: ____________________

5. A relief valve on an indirect service water heater is designed to keep the temperature of the water in the tank from exceeding:

   (a) 85°C
   (b) 99°C
   (c) 100°F
   (d) 150°C
   Code Ref: ____________________

6. Every pipe that conveys water from a relief valve on a hot water tank shall:

   (a) be equal in size to the cold water supply
   (b) be equal in size to the hot water outlet
   (c) at least be equal in size the outlet of the valve
   (d) be at least equal in size to the tanks drain valve

   Code Ref: ________________

7. A shut off valve shall be installed on the pipe between the hot water tank and the relief valve for servicing the relief valve:

   (a) within the top six inches of the hot water tank
   (b) between six and twelve inches off the floor
   (c) only on commercial hot water tanks
   (d) not permitted

   Code Ref: ________________

8. A single shower drain shall not serve more than:

   (a) 4 shower heads
   (b) 6 shower heads
   (c) 8 shower heads
   (d) 12 shower heads

   Code Ref: ________________

9. What type of backflow preventer is required to achieve premise isolation of a hospital or mortuary?

   (a) dual check valve
   (b) single check valve
   (c) double check valve
   (d) reduced pressure principle

   Code Ref: ________________

10. On-site constructed interceptors shall be constructed:

    (a) to plumber's specifications
    (b) to the inspector's specifications
    (c) to the requirements of a manufactured interceptor
    (d) according to past performance of an interceptor

    Code Ref: ____________________

END OF MODULE

MODULE 8

OTHER REQUIREMENTS

PLUMBING – ALL BUILDINGS - 2007

MODULE CONTENTS Page

Learning Objectives 8.2
Introduction 8.2
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Other Requirements for Plumbing Facilities 8.5
Barrier-Free Requirements 8.8
Fire Protection Requirements Related to Plumbing 8.10
Combustible Piping and Fixtures 8.10
Non-Combustible Piping Service Penetrations 8.13
Combustible Piping–Service Penetrations and Location of Piping 8.13
Public Pools and Spas 8.16
Plumbing Requirements for Public Pools and Spas 8.18
Module 8 Quiz 8.21

LEARNING OBJECTIVES

Upon completion of this module, participants will be able to:

- Determine the plumbing facility requirements for different occupancies
- Identify the barrier-free requirements that apply to fixtures
- Identify the fire protection requirements that relate to piping and fixtures
- Determine the plumbing requirements for Public Pools and Spas

INTRODUCTION

There are Code requirements located outside of Division B, Part 7 that apply to plumbing systems. These are important to know since a plumbing system always serves some type of occupancy and buildings may have certain constraints, such as the type of construction permitted, that will impact the design of the plumbing system.

Requirements in other parts of the OBC can be grouped into four categories:

- Minimum required plumbing facilities (such as washrooms) depending on the occupancy of a floor area
- Fire protection requirements such as types of pipe materials and firestopping of service penetrations
- Barrier-free design of plumbing facilities
- Water circulation systems and equipment for public pools and spas

Some of the terms used in this module may be unfamiliar to you. Look these terms up in Division A, or ask your facilitator or other participants what these terms mean.

PLUMBING FACILITIES

Plumbing facilities are dealt with in Subsection 3.7.4. of the OBC with the exception of dwelling units (which are dealt with in Subsection 9.31), and special types of buildings (which are dealt with in their own Subsections, such as Subsection 3.9. for portable classrooms).

Subsection 3.7.4. specifies that any building that abuts a street which a public or municipal water main is located must be provided with or have accessible to its occupants a *plumbing system* including a *potable* water supply, a *sanitary drainage system* and *plumbing fixtures*.

It is unlikely you will come across a building that does not provide the required number of fixtures, however you should know that Article 3.7.4.5. and Subsection 9.31.4. specify the following for a dwelling unit :

- Where a water distribution system is provided – a kitchen sink, lavatory, bathtub or shower stall, and a water closet
- Laundry facilities, or space for laundry facilities, or laundry facilities elsewhere in the building accessible to all occupants
- Hot water supply
- Floor drains in the basement

Washroom requirements for special types of buildings or floor areas can be found in the following articles:

3.7.6.	Food Premises
3.9.3.8.	Portable Classrooms
3.10.2.7.	Self-Service Storage Buildings
3.13.6.2.	Rapid Transit Stations
3.14.1.8.	Tents and Air-Supported Structures

NUMBERS OF REQUIRED PLUMBING FIXTURES

Articles 3.7.4.3. to 3.7.4.10. specify how many water closets are required for various types of occupancies, and sometimes various uses within those occupancies. The number of lavatories is based on the number of water closets, as per Sentence 3.7.4.2.(5). In general, 1 lavatory is required for every 2 water closets.

The procedure for calculating the number of water closets and lavatories required is as follows:

1. Determine the number of persons for which the area is designed or, if unknown, calculate the occupant load according to Subsection 3.1.17. For Group D occupancies, use 14 m^2 area per person, rather than 9.3 m^2 as given in Table 3.1.17.1. For Group E occupancies, consider staff occupant load as well as patron occupant load.

2. Note that the owner may use unit areas per person other than those of Table 3.1.17.1. to determine the occupant load, provided that a permanent sign indicating the occupant load is posted.

3. Consider the occupant load to be split 50/50 males and females unless it can determined with reasonable accuracy that the split is otherwise, as per Sentence 3.7.4.2.(2).

4. Using the resultant occupant load, use the appropriate table from Subsection 3.7.4.and compute the number of required water closets.

   Pay attention when applying the highest bracket in any table so that the number of water closets does not "jump" by one. For example, using Table 3.7.4.3.A., 351 – 400 males will require 6 water closets, 401 – 600 males will require 7 water closets, and 601 – 800 males will require 8 water closets.

   Note that urinals may be substituted for two-thirds the total number of water closets in most occupancies, as per Sentence 3.7.4.2.(3).

Note that one water closet and one lavatory is permitted for certain occupancies as per Sentence 3.7.4.2.(8).

5. Compute the number of required lavatories, based on Article 3.7.4.2.(5).

6. If washrooms are located on the entrance level, or on any storey served by a barrier-free path of travel, then washrooms must be designed and installed in accordance with Section 3.8.

7. Rooms containing sanitary facilities shall be designed so that toilets and urinals are not visible from the entrance to the washroom (Article 3.7.4.15.), or where food or drinks are served, stored or prepared (Article 3.7.6.3.).

OTHER REQUIREMENTS FOR PLUMBING FACILITIES

Subsection 3.7.4., 3.7.5, and 3.7.6. contain many requirements that are applicable to specific occupancies. Subsection 3.7.6. contains strict provisions for the locations of plumbing fixtures in "food premises", which is a defined term in Division A.

EXERCISE 8-1

Using the procedure outlined above, and Subsection 3.7.4., determine the numbers of plumbing fixtures (including lavatories) required in the following situations:

1. A retail store with an occupant load of 8 staff and 50 customers. The staff washroom(s) are accessible to the public.

____

____

____

____

Code Ref: ______________________________

2. A small manufacturing shop (300 m^2) with 8 occupants.

Code Ref: ____________________

3. A restaurant with 140 seats and 10 employees.

Code Ref: ____________________

4. Washrooms serving a 1000 m^2 office space.

Code Ref: ____________________

5. A child care facility with up to 15 children under 2 years old, and up to 30 children between 2 and 5 years old.

Code Ref: ____________________

6. A conference facility with meeting rooms with an occupant load of 1200 persons.

____

____

____

____

Code Ref: ______________________________

7. What kind of fixture(s) must be provided in a washroom containing urinals that are equipped with automatic flushing devices?

____

____

____

Code Ref: ______________________________

8. What kind of fixture(s) must be provided for employees within each food preparation area?

____

____

____

Code Ref: ______________________________

STOP

BARRIER-FREE REQUIREMENTS

Section 3.8. describes barrier-free design, which is applicable to most buildings. Exceptions to this are indicated in Article 3.8.1.1.

When a room is dedicated for the use of one barrier-free washroom, it is called a "universal toilet room", and is to be designed as per Article 3.8.3.12.

In general, at least one washroom on a floor area with a barrier-free path of travel needs to be barrier-free. This is usually provided by a barrier-free stall in each of the men's and women's washrooms, or by a universal toilet room.

If extra washrooms are provided on the floor, they do not need to be barrier-free if there is a barrier-free washroom within 45 metres. Read Article 3.8.2.3. to determine if washrooms are required to be barrier-free.

Articles 3.8.3.8. to 3.8.3.13. contain requirements related to the barrier-free design of washrooms. Specifically, water closet stalls, water closets, lavatories, showers and bathtubs are regulated.

EXERCISE 8-2

Read Articles 3.8.1.1. and 3.8.2.3. and Articles 3.8.3.8. to 3.8.3.13. and answer the following questions.

1. What buildings do the requirements of Section 3.8. apply to?

   ____

   ____

   ____

   ____

   ____

   Code Ref: ______________________

2. A department store is adding a new specialty shopping area within their existing store, and they plan to construct additional washrooms for the public in that area. If these washrooms are in excess of those required by Section 3.7.4., and they are 60 metres from the existing public washrooms on the same floor, are the new washrooms required to be barrier-free?

   ____

   ____

   Code Ref: ______________________

3. What are the minimum dimensions of a barrier-free water closet stall, and the location of the toilet in the stall?

   ____

   ____

   Code Ref: ______________________

4. What are the required features of a barrier-free water closet?

   ____

   ____

   ____

   ____

   ____

   Code Ref: ______________________

5. What is the minimum clearance beneath a barrier-free lavatory?

   ____

   ____

Code Ref:

6. What is the requirement for lavatory pipes?

Code Ref:

STOP

FIRE PROTECTION REQUIREMENTS RELATED TO PLUMBING

The fire protection aspects of plumbing pipes are regulated in the following areas:

- The use of combustible plumbing pipes and the material characteristics of combustible plumbing pipes and fixtures
- The firestopping of plumbing service penetrations

COMBUSTIBLE PIPING AND FIXTURES

Flame-Spread/Smoke-Developed Ratings and Surface Burning Characteristics

In 2005, the total fire loss in Ontario was $450 300 000. The fire death rate was 6.8 per million population. This information was taken from a table on the Office of the Ontario Fire Marshall website under the Ontario Fire Death Rate 1996-2005.

The threat of fire is real. Despite efforts to restrict the use of combustible materials in building construction, and fire-department programs to prevent ignition, fires continue to start. Whether these fires grow, and how quickly, depends to a large extent on the flammability of building materials, contents and building design. The more quickly a fire develops, the less time building occupants have to escape.

The verification of flame-spread rating (FSR) and smoke-developed classification (SDC) of interior finish materials is dealt with during more technical courses on Division B Part 3. However, some information is presented here on the scientific origin of the FSR/SDC values set by the Code.

The fire tests from which surface burning characteristics are determined are performed in a tunnel furnace. The tests are from CAN/ULC-S102-03 in the case of self-supporting materials; and CAN/ULC-S102.2-03 for flooring, floor-covering materials, and materials that are not self-supporting such as thermoplastics and loose-fill materials.

The material to be tested is placed in a standard 8200 mm long test chamber. A controlled flame is applied to the 7315 mm by 515 mm sample inside the tunnel furnace. Engineers plot the distance the flame travels along the surface of the material against measured time.

The results of individual tests are compared against the known values of red oak and asbestos cement board. When the testing program was started, red oak was tested and arbitrarily assigned a flame-spread rating of 100, whereas asbestos cement board was assigned an FSR of 0. All materials tested afterwards were measured in relation to these two benchmarks.

Smoke-developed classification (the other surface burning characteristic) is measured at the same time, by photoelectric circuits. The greater the amount of smoke, the less light crosses the circuit. In this test, a value of 500 is recorded when no light crosses the circuit. It is assumed that under these conditions, it would be impossible to see building egress routes.

Permitted Combustible Piping in Combustible Buildings

Part 9 buildings are always permitted to be of combustible construction. However, there are still restrictions on where combustible piping can be located. These restrictions are given in Article 9.10.9.7.

The basic rule is that combustible piping is not permitted through a rated fire separation. However, the Article goes on to list the exceptions to this rule, which includes combustible piping:

- Not in a vertical shaft, provided it is sealed by a firestop system
- On one side of vertical fire separation (i.e. a wall) that is not a vertical shaft, provided the building is sprinklered
- On one side of a horizontal fire separation (i.e. a floor) in a building containing only 2 dwelling units

Article 3.1.9.4. contains similar provisions for combustible piping penetrations in Part 3 buildings.

Permitted Combustible Piping in Noncombustible Buildings

When a building is required to be noncombustible, additional restrictions on the types of combustible piping are applicable.

Article 3.1.5.16. states that combustible piping is permitted in a building required to be of noncombustible construction provided it:

- Is sealed in a concrete slab, or
- Has a flame spread rating not more than 25, and
- A smoke developed classification of not more than 50 if it is a high building.

These requirements mean that ABS is not permitted in high buildings since it has a flame spread rating of more than 25. PVC has a flame spread rating less than 25, but most PVC pipes do not meet the smoke developed classification and cannot be used in high buildings. CPVC generally meets both the material characteristics and can be used in high buildings.

Combustible plumbing fixtures are permitted in a building required to be of noncombustible construction if they meet the same flame spread rating and smoke developed classification requirements that interior finishes need to satisfy.

NON-COMBUSTIBLE PIPING SERVICE PENETRATIONS

When pipes penetrate fire separations, a firestop system is required so that the integrity of the fire separation is maintained. Firestop systems for Part 3 buildings must be tested to ULC-S115 "Fire Tests for Fire Stop Systems" as per Sentence 3.1.9.1(1). The listing for the firestop system can be checked to confirm the system has been tested.

When a noncombustible pipe penetrates a fire separation it needs a firestop system with an F rating the same as a closure in the fire separation as per Sentence 3.1.9.1.(1).

Use Table 3.1.8.4. to determine the rating of a firestop system. For example, a pipe penetration through a 1 hour fire separation will require a firestop system with a 45 minute F rating.

A firewall requires a firestop system to have an FT rating equal to the rating of the firewall. The "T" stands for temperature, and it means the firestop system needs to meet a maximum temperature rise criterion in the fire test. So a steel pipe through a 2 hour firewall will require a firestop system with a 2 hour FT rating.

COMBUSTIBLE PIPING SERVICE PENETRATIONS AND LOCATION OF PIPING

Combustible piping also requires firestopping. These firestop systems are typically made of intumescent material that expands in the heat of a fire. The material will fill the space left by the pipe and maintain the integrity of the fire separation.

Article 3.1.9.4. requires that the firestop system for combustible piping have an F rating the same as the fire separation it passes through, and it also has to pass the fire test with a pressure differential between the exposed and unexposed sides.

If combustible piping is located in a concealed space that is used as a plenum, such as a return air space above a suspended ceiling, in a building that is required to be noncombustible, it needs to meet a maximum FSR or 25 and SDC of 50 as per Article 3.6.4.3.

EXERCISE 8-3

Read Articles 3.1.5.16., 3.1.5.17., 3.1.9.1., 3.1.9.2., 3.1.9.4., 3.1.13.3., 3.1.13.7., and 3.6.4.3. Answer the following questions by yourself, then check your answers with others when completed.

1. What is the maximum flame-spread rating and smoke developed classification of a combustible pipe when installed within a high-rise building?

   ____

   ____

   Code Ref: ______________________________

2. What is the maximum flame-spread rating and smoke developed classification of combustible fixtures when installed within a high-rise building?

   ____

   ____

   ____

   ____

   Code Ref: ______________________________

3. What is the OBC requirement when a non-combustible pipe penetrates a firewall?

Code Ref:

4. What is the OBC requirement when a combustible pipe penetrates a fire separation required to have a fire-resistance rating?

Code Ref:

5. Can combustible pipes be located within a protected fire-rated vertical service space?

Code Ref:

STOP

PUBLIC POOLS AND SPAS

The OBC began incorporating design and construction requirements for public pools in 1989, and the applicable requirements have evolved to also cover public spas. Sections 3.11. and 3.12. of the 2006 OBC contain these requirements.

The requirements cover the physical design of pools, and they include the following areas related to plumbing:

- maximum opening size for fittings
- number of required gravity drains
- maximum water velocity
- prohibition of submerged vacuum and skimmer equalizer fittings
- water circulation rates
- chlorination rates for wave action pools
- emergency signals and switches

The definitions of a **public pool** and a **public spa** help to understand the installations that are governed by the OBC. Also, Article 3.11.2.1. describes **Class A and Class B public pools**. Other types of pools are called **modified pools** and **wave action pools**.

EXERCISE 8-4

Read the following definitions in Division A and Article 3.11.2.1., and write a short description of each type of pool in your own words in the chart below.

Summary of Types of Pools and Spas Regulated by the OBC
(Division A, Article 1.4.1.2. and Division B Subsection 3.11.)

Type of Pool	Brief Description	Code Reference
Public Pool		
Class A		
Class B		
Modified Pool		
Wave Action Pool		
Public Spa		

STOP

PLUMBING REQUIREMENTS FOR PUBLIC POOLS AND SPAS

Here is a highlight of plumbing reuqirements for public pools and spas in Sections 3.11. and 3.12.:

Recirculation systems for public pools are regulated by Subsection **3.11.8.** Requirements deal with contamination of the potable water supply, disinfection of pool water, and fittings in pools that are part of the recirculation system. Sentence 3.11.8.1.(5) requires a recirculation system to filter, disinfect and pass through the pool each day between 3 and 6 times the volume of the pool, depending on the type of pool.

Water circulation systems for public spas are regulated by Subsection **3.12.4.**

Dressing rooms and sanitary facilities for public pools are regulated by Subsection **3.11.9.** Requirements deal with what facilities are required, the design of the facilities, and safety and privacy provisions. Of note, at least one shower head is required for every 40 bathers, all shower heads require a supply of potable water at a pressure of 140 kPa, and the maximum temperature of the water in the shower system is 40°C. Hose bibs are required in safe locations to wash walls and floors in washrooms, shower areas and passageways used by bathers.

Service rooms and storage facilities are addressed by Subsection **3.11.11.** Compressed chlorine gas has specific storage restrictions.

EXERCISE 8-5

Answer the questions by yourself, check your answers with the others when completed.

1. What is the maximum flow of water through suction or gravity fittings in a public pool?

   ____

   ____

   Code Ref: ______________________________

2. What is the required colour coding of exposed potable water piping and chlorine piping within a public pool water treatment service room?

   ____

   ____

   Code Ref: ______________________________

3. What is needed to separate a public pool and its recirculation system from a potable water supply?

   ____

   ____

   ____

   Code Ref: ______________________________

4. Minimum 2 outlets separated by 1200 mm, clearly and permanently marked with 50 mm wide band of contrasting colour. 3.11.8.1.(15) & (18)

4. What are the requirements for fittings located below the water surface that are providing suction or gravity flow in a public pool?

   ____

   ____

   Code Ref: ______________________________

5. What is the maximum hot water temperature for a public spa water heater?

____

____

Code Ref: ________________________________

6. Is combustible piping for a pool or spa permitted in a building required to be of noncombustible construction?

____

____

Code Ref: ________________________________

7. What is the minimum water pressure and maximum water temperature for shower heads for public pools?

____

____

Code Ref: ________________________________

8. How must a pool deck drainage system be connected to a sewer or other drainage system?

____

____

Code Ref: ________________________________

STOP

MODULE 8 QUIZ

1. For a restaurant classified as mercantile occupancy, the required number of water closets must be provided:

   (a) in accordance with Article 3.7.4.8.(4)
   (b) in accordance with Article 3.7.4.3.
   (c) not more than one water closet is required to serve both sexes
   (d) at least one water closet is required for the employees

   Code Ref: ________________

2. Where a male washroom is required to be provided with five water closets in accordance with Table 3.7.4.7.:

   (a) one urinal and four water closets is acceptable
   (b) two urinals and three water closets is acceptable
   (c) three urinals and two water closets is acceptable
   (e) five water closets must be provided

   Code Ref: ________________

3. When five water closets are required to be provided in an industrial occupancy male washroom, how many lavatories are required?

   (a) 2
   (b) 3
   (c) 4
   (d) 5

   Code Ref: ________________

4. What kind of plumbing facility is required to be provided in a pharmacy?

   (a) water closet
   (b) sink
   (c) shower stall
   (d) washroom containing a water closet and a lavatory

   Code Ref: ________________

5. What is the required maximum allowable hot water temperature supplied by an office lavatory?

   (a) 40 °C
   (b) 45 °C
   (c) 49 °C
   (d) not regulated by the Building Code

   Code Ref: ___________________

6. The preparation area of a 50 m^2 retail food premise that sells only hot beverages must provide a:

   (a) separate lavatory for employees
   (b) separate lavatory for customers
   (c) two-compartment sink
   (d) three-compartment sink

   Code Ref: ___________________

7. Can exposed combustible piping be installed in a building required to be of non-combustible construction?

   (a) permitted within a suite
   (b) not permitted within a suite
   (c) may be permitted in this building
   (d) not permitted in this building

   Code Ref: ___________________

8. What is the OBC requirement when a combustible pipe is located within a return-air plenum of a single storey small office building? The pipe:

(a) is only required to have a flame-spread rating of not more than 25
(b) is only required to have a smoke developed classification of not more than 50
(c) is required to have a flame-spread rating of not more than 25 and a smoke developed classification of not more than 50
(d) must be non-combustible

Code Ref: ____________________

9. What is the OBC requirement when a combustible pipe penetrates a fire separation required to have a fire-resistance rating in a non-combustible building?

(a) it must be sealed with a fire stop system that has an F rating and can withstand a pressure differential of 50 Pa
(b) both side of the fire compartments must be sprinklered
(c) the fire separation must be of either concrete or masonry construction
(d) it must be sealed with a fire stop system that has an F rating of 45 minutes

Code Ref: ____________________

10. What is the maximum water velocity in a suction pipe in a water circulation system serving a public spa?

(a) 1.6 m/s
(b) 1.8 m/s
(c) 2.8 m/s
(f) 3.0 m/s

Code Ref: ____________________

END OF MODULE

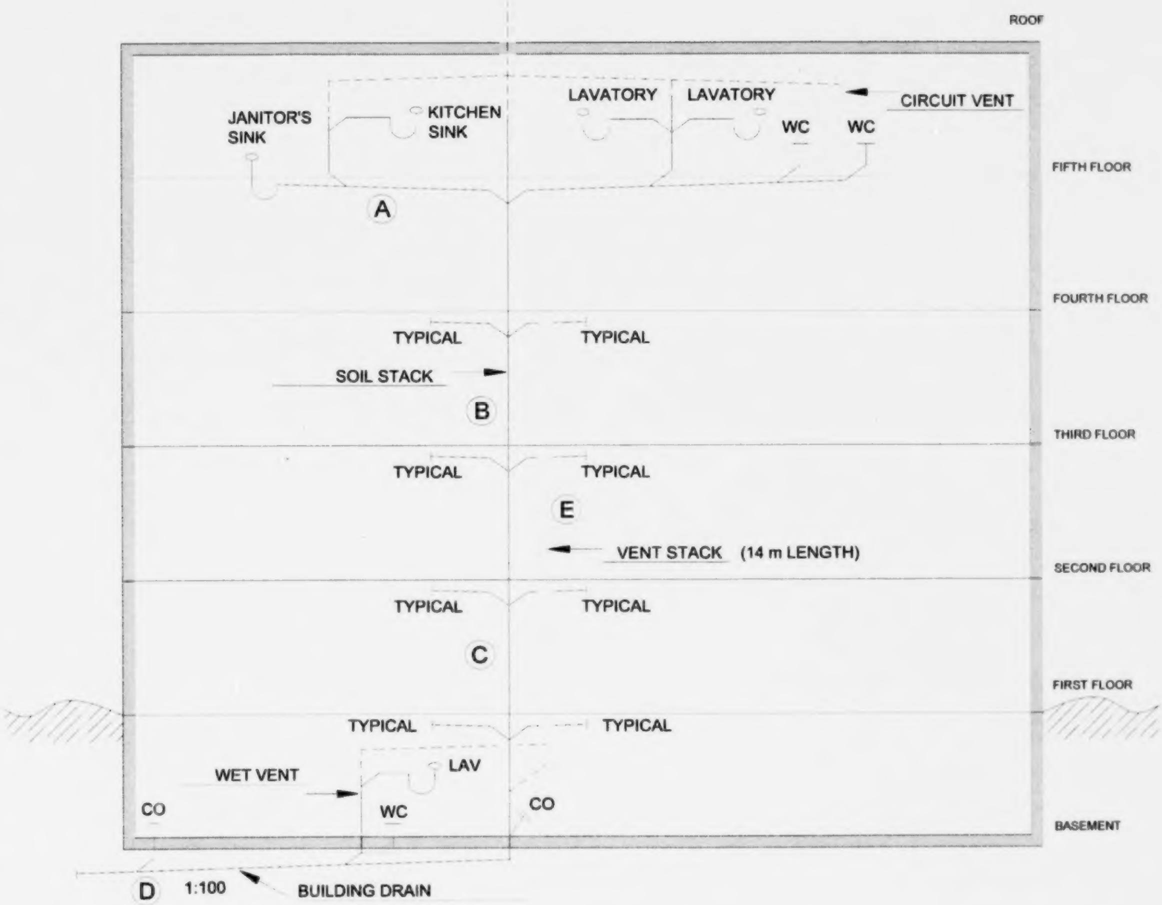
APPENDICES

ANSWER GUIDE

PLUMBING – ALL BUILDINGS - 2007

MODULE 1

Pre-Course Exercise


ROOF
JANITOR'S SINK
KITCHEN SINK
LAVATORY
LAVATORY
WC
WC
CIRCUIT VENT
FIFTH FLOOR
A
FOURTH FLOOR
TYPICAL
TYPICAL
SOIL STACK
B
THIRD FLOOR
TYPICAL
TYPICAL
E
VENT STACK (14 m LENGTH)
SECOND FLOOR
TYPICAL
TYPICAL
C
FIRST FLOOR
TYPICAL
TYPICAL
WET VENT
LAV
CO
WC
CO
BASEMENT
D
1:100
BUILDING DRAIN

Janitor's sink 2 in. trap	2
Kitchen sink	1.5
2 Lavatories @ 1	2
2 WC tank type @ 4	8
Total per floor	13.5 fixture units

Basement = 1 + 4 = 5 fixture units

	Pipe Type	Hydraulic Load Served (fixture units)	Size (in.)	Code Reference
A	Horizontal branch	2 + 1.5 = 3.5	2	7.4.9.1.(1)
B	Soil stack	13.5 + 13.5 = 27	3	Table 7.4.10.6.A.
C	Soil stack	27 + 13.5 + 13.5 = 54	4	7.4.9.2.(3)
D	Building drain	54 + 5 = 59	4	7.4.9.4.(1)
E	Vent stack	54 + 13.5 = 67.5	3	Table 7.5.8.4.

MODULE 2

Exercise 2-1

Terms defined in Division A Part 1.

Exercise 2-2

Stack A	Soil Stack
Stack B	Soil Stack
Stack C	Waste Stack
Stack D	Soil Stack
Point 1	Sanitary Building Drain
Point 2	Fixture Drain
Point 3	Horizontal Branch
Point 4	Horizontal Branch
Point 5	Sanitary Building Drain
Point 6	Cleanout
Point 7	Sanitary Building Drain
Point 8	Sanitary Building Sewer

Exercise 2-3

Table 7.4.9.3. unless indicated

1)	Domestic clothes washer	1½ fixture units
2)	3 compartment Laundry tray	2 fixture units
3)	Potato Peeler	3 fixture units
4)	Flush tank water closet	4 fixture units
5)	Siphon jet urinal	4 fixture units
6)	Shower drain for six heads	6 fixture units
7)	Industrial garbage grinder	3 fixture units
8)	Commercial dishwasher	3 fixture units
9)	2 in. trap, 3 fixture units,	Table 7.4.10.2.
10)	3 in. trap, 5 fixture units,	Table 7.4.10.2.

11) Continuous flow of 0.09 litres per second, 0.09 * 31.7 = 3 fixture units, 7.4.10.3.(1)
12) Semi-continuous flow of 0.1 litres per second, 6 fixture units, Table 7.4.10.3

Exercise 2-4

Horizontal Branch	Table: 7.4.10.7
1) 1¼ inch	2 fixture units

2) 1½ inch 4 fixture units
3) 2 inch 6 fixture units

Vertical Stack Table: 7.4.10.6.B
4) 1¼ inch 2 fixture units
5) 1½ inch 8 fixture units
6) 2 inch, serving a 4 storey building 24 fixture units

Exercise 2-5

OBC Tables for Sizing Sanitary Drainage Piping

Table	Type of Pipe Table Applies To	Information Required to Use Table
7.4.10.6.A.	Soil Waste Stack 3 in and larger	Fixture Units, maximum discharge per storey
7.4.10.6.B.	Vertical Drainage Pipe less than 3 in	Stack Height and Fixture units, maximum discharge per storey
7.4.10.8.	Horizontal Sanitary Drainage Pipe 3 in and larger	Fixture Units and Slope
7.4.10.7.	Horizontal less than 3 in	Fixture Units

Exercise 2-6

1. 7.4.9.2.(1) 3" minimum
7.4.9.2.(2) 4" minimum downstream of third water closet on horizontal branch
7.4.9.2.(3) 4" minimum when serving more than 6 water closets on every soil stack
7.4.9.2.(4) Macerating toilet min ¾ in.

2. 7.4.10.8.(2) 65% for horizontal piping.
7.4.10.6.(3) 29% for vertical sanitary drainage piping.

Exercise 2-7

1. Washroom A:

8 - 1¼" lavatories	-	8	fixture units
8 direct flush valve w/c	-	48	fixture units
2 - 3" floor drain	-	6	fixture units
Total Hydraulic Load		62	fixture units

Washroom B:

2 direct flush w/c	-	12	fixture units
6 - 1¼" lavatories	-	6	fixture units
4 shower stalls	-	6	fixture units
3 - 3" floor drains	-	9	fixture units
Total Hydraulic Load		33	fixture units

Washroom C:

2 - 1¼" lavatories	-	2	fixture units
2 bathtubs	-	3	fixture units
2 flush tank water closet	-	8	fixture units
2 shower stalls	-	3	fixture units
Total Hydraulic Load		16	fixture units

2) Minimum slope 1:50, 7.4.8.1.(1) if pipes less than 3 in.

3) Branch A: min 4in. due to 7.4.9.(2). In addition, Table 7.4.10.8 should be checked for minimum size (4 inch) for 62 FU

Branch B
4″ 33 Fixture Units Table 7.4.10.8

Branch C
3″ 16 Fixture Units Table 7.4.10.8.

Branch D
4″ 12 WC's on a horizontal branch 7.4.9.2.(2)

4) Section 1: 4" (7.4.9.2.(3))
Section 2: 4" (7.4.9.2.(3))
Section 3: 4" (7.4.9.2.(3))
All pipes 4″ under Table 7.4.10.6.A

Exercise 2-8

a) 4" building drain
Size 4" Maximum Distance 15 m 7.4.7.2.(1)(b)

b) 2" horizontal sink waste pipe
Size 2" Maximum Distance 6 m 7.4.7.2.(1)(a) and 7.4.7.1.(10)

c) 5" building sewer
Size 4" Maximum Distance 30 m 7.4.7.2.(1)(c)

d) 10" storm building drain
Size 4" Maximum Distance 30 m 7.4.7.2.(1)(c)

e) 6" horizontal branch
Size 4" Maximum Distance 30 m 7.4.7.2.(1)(c)

2. a) 4" pipe and smaller, same size as pipe. 7.4.7.2.(1)
b) Larger than 4" pipe, the clean-out shall be 4" or larger. 7.4.7.2.(1)

3. (1) improper sizing
(2) improper grading
(3) poor workmanship
(4) misuse

4. 7.4.7.1.(4) when building sewer is 8" or larger

7.4.7.2.(3) 30 m

Exercise 2-10

(1) Be designed to support all loads 7.4.7.3.(1)

(2) (a) airtight seal if located in a building 7.4.7.3.(2)(a),

(b) rigid, corrosion resistant ladder when more than 1 m deep, and

(c) vented to the exterior if located in a building

(3) 1200 mm min horizontal dimension, tapered to 600 mm at top

(4) channeled to direct flow of effluent

(5) min 2 inch vent pipe to serve manhole within a building

Exercise 2-11

Articles and titles are from the Code.

1. When a storm drainage system is connected to a public combined sewer 7.4.5.2.(1). This requirement is designed to prevent the introduction of sewer gas. See also 7.4.5.3.

2. When no storm drainage system is available or soil conditions prevent drainage to a culvert or dry well, Subsoil drainage piping may be connected upstream of a trap with a clean-out, see 7.4.5.3(2) & (3).

3. See 7.3.5.7. for details on locations of pipes and joints

4. Damage from backfill, crushing or cracking (asbestos cement or clay pipe under floors), load from walls on top, frost/freezing, mechanical damage, condensation

5. Sentence 7.4.6.4.(2) when it is a normally open design conforming to the applicable standard, and when it serves not more than one dwelling unit

Exercise 2-12

1) The connection shall be made by terminating the fixture drain above the flood level rim of a directly connected fixture to form a 25 mm air break. 7.3.3.11.(1) & (2)

2) Shall not be located in crawlspace or other unfrequented area, so that a problem such as overflow can be readily detected and the connection maintained or repaired 7.4.3.2.

3)
   - (i) a device for the display, storage, preparation or processing of food or drink
   - (ii) a sterilizer
   - (iii) a device that uses water as a cooling or heating medium
   - (iv) a water operated device
   - (v) a water treatment device
   - (vi) a drain or overflow from a water system or heating system

4) Yes. 7.4.2.3.(1)- branch must be at least 1¼ inch,
Is terminated above the flood level rim of a directly connected fixture with a minimum diameter waste of 1½ inch to form an air break

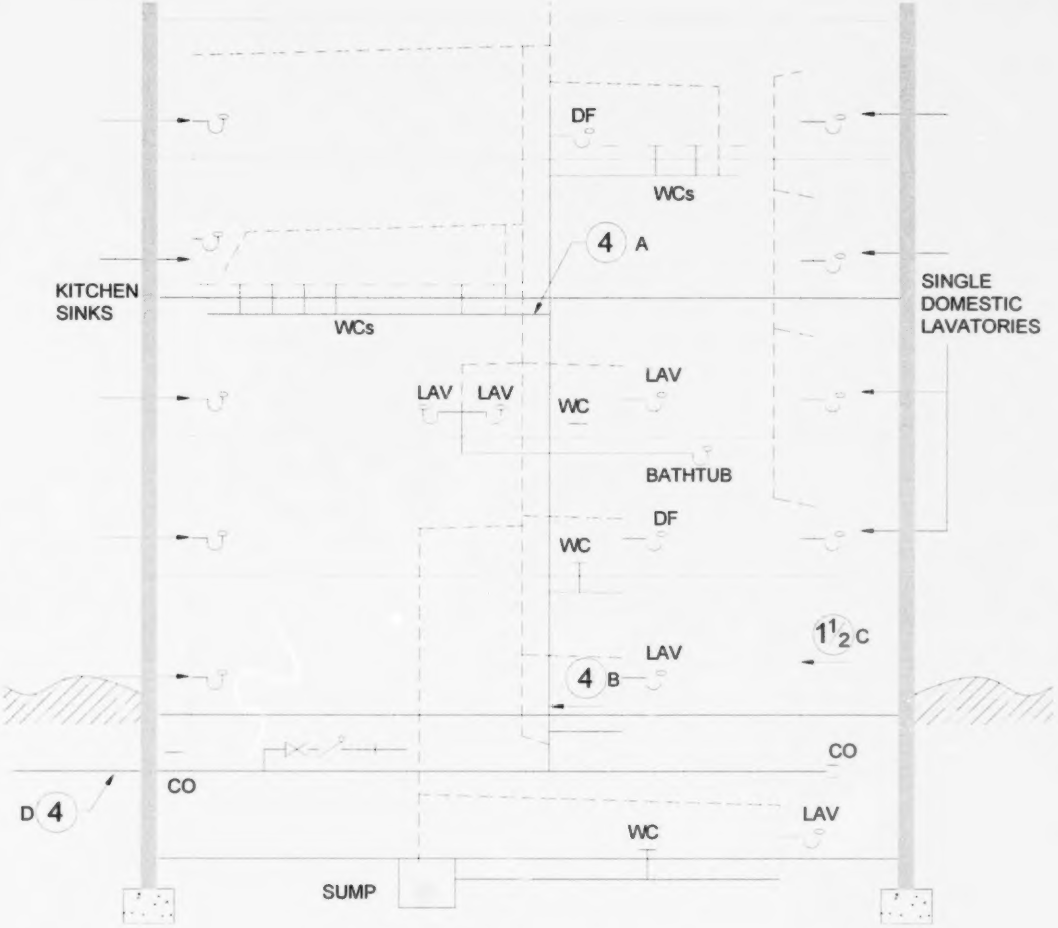
5) 25 mm (1 inch) 7.3.3.12.(2)

6) indirect connection with an air break OR direct connection with a backwater valve, 7.4.2.1.(1)(h)

Exercise 2-13

1. Water Test and Air Test
   Final test (just on final inspection)
   Ball test on building drains and building sewers only
2. Water test or air test
3. If a water test is not possible; e.g., when the temperature is below freezing.
4. *On building drains and sewers underground, Sentence 7.3.6.1.(5), Sentence 7.3.6.1.(5)*
5. In accordance with Article 7.3.6.6.

Exercise 2-14


DF
WCs
4 A
KITCHEN SINKS
WCs
SINGLE DOMESTIC LAVATORIES
LAV
LAV
LAV
WC
BATHTUB
DF
WC
1½ C
LAV
4 B
CO
CO
D 4
LAV
WC
SUMP

NOTE: FITTINGS NOT SHOWN

A – 4 inch – horizontal branch, 10 WCs @ 6 fu each = 60 fu, Table 7.4.10.8., 4 in pipe

B – 4 inch – soil stack, 16 WCs, 3 lavatories, 2 drinking fountains = 100 fu, Table 7.4.10.6.A., 4 in stack

C – 1 ½ inch – waste stack, 4 lavatories = 4 fu, Table 7.4.10.6.B., 1 ½ in pipe acceptable

D – 4 inch – building drain, sump pump flow of 0.2 L/s equivalent to 27 fixture units based on Table 7.4.10.3.,total load is 100+4+27+7.5 = 139.5 fixture units, Table 7.4.10.8. and 7.4.9.4.(1) 4 in. pipe

Exercise 2-15

Step 1: Calculate surface area drained.

RL1: 20 m x 18 m = 360 m^2
Largest adjacent vertical surface to RL1 is n/a:
= (1/2 x 0m) = 0
Total area drained by RL1 = 360 m^2

RL2: 15 m x 18 m = 270 m^2
Largest adjacent vertical surface to RL2 is:
= (1/2 x 3 m x 18 m) = 27 m^2
Total area drained by RL2 = 297 m^2

RL3: 15 m x 18 m = 270 m^2
Largest adjacent vertical surface to RL3 is n/a:
= (1/2 x 0) = 0
Total area drained by RL3 = 270 m^2

Step 2: Find the local rainfall intensity (15 minute rainfall).

The building is located in Bancroft. From Table 1.2 in SB-1, Column 7:
15 min Rainfall = 25 mm

Step 3: Determine the hydraulic load.

RL1 = 25 mm x 360 m^2 = 9 000 L
RL2 = 25 mm x 297 m^2 = 7 425 L
RL3 = 25 mm x 270 m^2 = 6 750 L

Step 4: Determine the size of the rain leaders.

Use Table 7.4.10.10.

RL1: A 4 inch circular rain leader will serve a hydraulic load of 9 000 L.
RL2: A 4 inch circular rain leader will serve a hydraulic load of 7 425 L.
RL3: A 4 inch circular rain leader will serve a hydraulic load of 6 750 L.

Step 5: Determine the horizontal storm drain size.

The horizontal storm drain carries the hydraulic load from RL1 of 9 000 L. Column 5 applies in Table 7.4.10.9. for a pipe at a slope of 1 in 100. The horizontal storm drain is required to be 6 inches.

The horizontal storm drain carries the hydraulic load from RL1 and RL2: 9 000 L + 7 425 L = 16 425 L. Column 5 applies in Table 7.4.10.9. for a pipe at a slope of 1 in 100. The horizontal storm drain is required to be 8 inches.

Step 6: Determine the horizontal storm sewer size.

The total hydraulic load from RL1, RL2 and RL3:
9 000 L + 7 425 L + 6750 = 23 175 L. With a slope of 1 in 100, the horizontal storm sewer is required to be 8 inches.

Summary:
Rain Leader 1 = 4 inch
Rain Leader 2 = 4 inch
Rain Leader 3 = 4 inch
Horizontal Storm Drain for RL1 = 6 inch
Horizontal Storm Drain for RL1 and RL2 = 8 inch
Horizontal Storm Sewer = 8 inch

Module 2 Quiz
1. (a) Division A 1.4.1.2.
2. (d) Division A 1.4.1.2.
3. (d) 7.4.9.1.(1)
4. (b) 7.4.9.2.(2) Table 7.4.9.3.
5. (b) 7.4.9.2.(3)
6. (c) 7.4.9.3.(2)
7. (a) 7.4.7.1.(7)
8. (d) 7.4.3.2.2(1)
9. (a) 7.4.6.3.(8)
10. (c) 65% 7.4.10.8.(2)
11. A 2" vertical stack per Column 3 and 4 of Table 7.4.10.6.B.

12.

Stack No.	Fixtures	F.U.s	Total F.U.s
Soil Stack 1	6 - bathroom groups	6x6=36	
	6 - kitchen sinks	6x1.5=9	45
Waste Stack 1	6 – 3 in. floor drains	6x3=18	
	6 – 1 ½ in auto washers	6x1.5=9	21
Soil Stack 2	3 – bathroom groups	3*6=18	
	3 – kitchen sinks	3x1.5=4.5	22.5
Waste Stack 2	3 – 2 in. floor drains	3x2=6	
	3 – 1 ½ in. auto washers	3x1.5=4.5	10.5
Soil Stack 3	2 – bathroom groups	2x6=12	
	2 – kitchen sinks	2x1.5=3	
	2 – 2 in. floor drains	2x2=4	
	2 – 1 ½ auto washers	2x1.5=3	22

Location	Fixture Units/Sizing Considerations	Pipe Size
A	22 fu, 2WCs	3 in.
B	10.5 fu, no WCs, Table 7.4.10.6.B. Col.3	2 in.
C	22.5 fu, 3WCs	3 in.
D	21 fu, no WCs, but 3 in floor drains require 3 in. drain 7.4.9.1.(1)	3 in.
E	45 fu, 6 WCs, 7.4.9.2.(3) not yet applicable, max 2 WC per floor so 3 in. horizontal branches, Table 7.4.10.6.A requires 3 in.	3 in.
1	22 fu, 2 WCs, building drain min 4 in. 7.4.9.4.(1)	4 in.
2	B+C = 33 fu, 3 WCs, downstream of 3rd WC fixture drain, 7.4.9.2.(2)	4 in.
3	A+B+C = 55 fu, 5 WCs, building drain min 4 in. 7.4.9.4.(1), also not lesser than upstream drainage pipes 7.4.9.1.(1)	4 in.
4	D+E = 66 fu, 6WCs, 3 in. pipes upstream, Table 7.4.10.8	4 in.
5	A+B+C+D+E or 3+4 = 111 fu, 11 WCs, building drain min 4 in. 7.4.9.4.(1), 4 in. ok Table 7.4.10.8.	4 in.

MODULE 3

Exercise 3-1

1. Lavatory, sink or laundry tray. Code reference: Sentence 7.2.3.1.(3)
2. 38 mm 7.2.3.1.(1)(a), 50 mm for an acid waste system 7.2.3.1.(2)

Exercise 3-2

1.They exceed maximum fall permitted before connection of vent. 7.2.3.1.(4)
2. May be used on a laboratory sink or other fixture with corrosion resistant fittings.
7.2.3.1.(6) & (7)
3. 1) Large body does not permit self-cleansing
2) possibility of undetected leak in pipe inside the trap
4. P-Trap

Exercise 3-3

1. Partial or complete loss of liquid which forms the seal in the trap.

2. Provisions shall be made for maintaining the trap seal of a floor drain. 3/8 tubing shall be used when supplied by a mechanical device. Sentence 7.4.5.5.(1) & (2)

3. Appendix note A.7.4.5.5.(1) from 1997 OBC shows other methods. Examples are: primer tubes from laundry tubs and drinking fountains

4. Answers from discussion in module on siphonage

5. Answers from discussion in module on siphonage

Module 3 Quiz

1 a)
2 d)
3 b)
4 e)
5 a)
6 d)
7 e) Sentences 7.2.3.1.(4) & (5)
8 d)) 7.2.3.1. and 7.5.1.1.
9 a) Sentence 7.4.2.1.(2)
10) Sentence 7.5.6.3.(1)

MODULE 4

Exercise 4-1
Answers can be found in Division A of the OBC

Exercise 4-2

1. Not less than twice the size of the fixture drain. If closer, it could promote evaporation of the trap or waste could splash up into the vent eventually causing it to clog.
OBC Reference: Clause 7.5.6.3.(1)(a)

2. 1 in 50. Helps to promote self-cleansing
OBC Reference:. Table 7.5.6.3.

3. Not more than 1.5 metres for 2 in. and smaller traps. Maximum length is up to 5 m for a 6 in. trap. If too long, the total amount of fall could exceed the diameter of the drain pipe causing self-induced siphonage Permitted length increases as trap size increases because the diameter of the pipe allows a greater fall before self-induced siphonage would occur..
OBC Reference: Table 7.5.6.3

4. Not greater than its inside diameter. Same principal as above.
OBC Reference: Clause 7.5.6.3.(1)(b).

5. Not more than 135 degrees cumulative change of direction. This allows for waste to flow with little restriction
OBC Reference: Clause 7.5.6.3.(1)(c).

6. Max 1000 mm vertically and 3 m horizontally between vent pipe and fixture drain connection to fixture
OBC Reference: Sentence 7.5.6.3.(3)

Exercise 4-3

Definitions can be found in Division A of the OBC

Exercise 4-4

1. Continuous vent means a vent pipe that is an extension of a vertical section of a branch of fixture drain.
2. Back vent means a pipe that is installed to vent a trap off the horizontal section of a fixture drain or the vertical leg of a water closet or other fixture that has an integral siphonic flushing action and "back vented" has a corresponding meaning.

3. A continuous waste vent is an extension of a vertical branch of a fixture drain; a dry vent is not an extension of the fixture drain.

4. A continuous waste vent is an extension of a vertical branch of a fixture drain; a dry vent is not an extension of the fixture drain.

1. Dual vent 2. Back Vent 3. Continuous vent 4. Back vent

Exercise 4-5

Definitions can be found in Division A of the OBC.

Exercise 4-6

1. A vent stack is required to serve a soil or waste stack over 4 storeys. There is an exception when the soil or waste stack serves as a wet vent. 7.5.4.2.

2. Conditions as per 7.5.4.2.(4) (a) to (e)

3. Everywhere there is a soil or waste stack. There are no exceptions 7.5.4.1.(1).

Exercise 4-7

1. Maximum 2 water closets 7.5.2.1(1).(b).

2. Connected at the same level to a vertical part of the stack by means of a double fitting per Table 7.2.4.5., downstream of all other fixtures 7.5.2.1.(c)(d).

3. Yes, the length of a wet vent is not restricted, also not restricted to a single storey. Limitations are on hydraulic load (max 4 fu), WCs not permitted 7.5.2.1.(1)(h).

4. Advantages:
- Less piping to be installed
- Waste water flushes vent to keep it clean

Disadvantages:
- If wet vent becomes blocked, the vent for the other fixture is also blocked.
- Also waste accumulation may reduce diameter and effectiveness of the vent

5. The limitations ensure that both drainage and venting functions can be properly performed.

Exercise 4-8
Examples from class.

Exercise 4-9

1. Definitions in Division A.
2. a section of a horizontal branch 7.5.3.1.(1)
3. When cumulative change in direction >45°, when serving more than 8 circuit vented fixtures 7.5.3.1.(6)

4. Relief vent can serve a maximum of 2 braches. The condition is that there are not more than 8 cumulative fixtures on each branch.7.5.3.1.(5)

Exercise 4-10

1. Definitions can be found in Division A of the OBC.

2. No - 7.5.4.4.Hydraulic load each apartment - (6+1.5+1= 8.5), for building 8.5 x 10 = 85 Although the offset is greater than 1 500 mm, and passes through more than 2 storeys the total hydraulic load is less than 100 fixture units

Exercise 4-11

1. When a soil or waste stack receive discharge from more than eleven floors. 7.5.4.3.(1)

2. 7.5.4.3.(1)(a) Five storeys

3. 7.5.4.3.(3) a yoke vent shall be connected to a vent stack at least 1 m above the floor level. 7.5.4.3.(2), and by a drainage fitting at or immediately below the lowest soil or waste pipe from the lowest storey or sections

4. A yoke vent is a form of relief vent used in buildings of more than eleven storeys to relieve pressure built up by the discharge from higher floors.
5. 4 yoke vents required

Exercise 4–12

Minimum Sizes of Pipes for Equipment
(Subsections 7.5.5. and 7.5.7.)

Equipment	Minimum Vent Size (in.)	Code Reference
Sanitary sewage sumps or tanks	2	7.5.5.1., 7.5.7.7.
grease and oil interceptors	1½	7.5.5.2
acid waste dilution tank	2	7.5.5.2., 7.5.7.7.
corrosive drain piping and dilution tanks	2	7.5.5.3., 7.5.7.7.
fresh air inlet for building trap	4	7.5.5.4.
manholes within a building	2	7.5.7.6.
macerating toilet system sump or tank	1½	7.5.7.7.(3)

Exercise 4-13

Assume 1 ½ in trap, 1 ¼ in vent pipe

1. Equivalent to 3 in. trap, 1 ½ in. vent pipe
2. 1 ½ in. vent pipe

Exercise 4-14

Developed Length for Sizing Vents
(Articles 7.5.8.3. and 7.5.8.4.)

Type of Vent	Developed Length Measured	
	From…	To…
Branch Vent	The most distant soil or waste pipe connection	A vent stack, stack vent, header or open air
Continuous Vent	Vertical soil or waste pipe connection	A vent stack, stack vent, header or open air
Header	The most distant soil or waste pipe connection	Open Air
Circuit Vent	Horizontal soil or waste pipe connection	Vent stack, stack vent, header to open air
Vent Stack	Lower end	to open air
Stack Vent	Lower end	to open air

Exercise 4-15

1. 7.5.8.2.Individaul and Dual vents. 7.5.8.5. Additional Circuit Vent, offset relief vent, relief vent, yoke vent, and the vent pipe for an interceptor, dilution tank, sanitary sewage tank or sump, or manhole.

2. The primary function of these vent pipes is to maintain atmospheric pressure in the drainage system. There is no specified hydraulic load that these vent pipes serve. The code establishes their minimum sizes based on the vent pipes they are connected to.

3.

Vent	Type of Vent	Length to be considered
A-C	Vent Stack	ACEGIKL
B-C	Vent Stack	BCEGIKL
H-1	Vent Stack	HIKL
D-E	Stack Vent	DEGIKL
F-G	Stack Vent	FGIKL
J-K	Stack Vent	JKL
CEGIKL	Vent Header of any section of it	ACEGIKL

Exercise 4-16

1. Governed by 7.5.7.2.(1), branch vent must be at least 1 ½ in
2. Does not depend on the size of drainage pipe. 2 inch circuit vent Table 7.5.8.3.
3. 7.5.7.2.(1), header must be at least 3 in since it serves a 3 in. vent pipe, Table 7.5.8.3..
4. Table 7.5.8.3., 3 fixture units requires a 1 ½ in vent.

Exercise 4-17

1. 2 inch stack vent - Using 3 in. soil stack row, max 53 fixture units, max 28.5 metre length. This is more than one-half of the soil stack size.
2. 4 inch vent stack – Using 5 in. soil stack row, max 1400 fixture units, max 58 metres length. This is more than one half the soil stack size.

Exercise 4-18

Step 1. Determine the hydraulic loads of each fixture.

Find these from Table 7.4.9.3.

Lavatory Basin	1 fixture unit
Kitchen Sink	1.5 fixture units
2 head shower	3 fixture units
WC (flush tank)	4 fixture units

Step 2. Determine the hydraulic load carried by the wet vent.

The wet vent does not drain the water closet, so this is not included in the calculation, as per Sentence 7.5.8.1.(2). But the wet vent must consider the hydraulic load of the kitchen sink that drains to the trap arm of the water closet as per 7.5.2.1.(f).

Wet vent hydraulic load = lavatory + lavatory + 2-head shower + 2-head shower + kitchen sink = 9 fixture units

Step 3. Size the wet vent.

From Table 7.5.8.1., the wet vent is serving a water closet, so Column 3 is used. Since the hydraulic load is 9 fixture units, the wet vent pipe size is 4 in.

Step 4. Determine the hydraulic load served by the continuous vent.

Use only the hydraulic load that is wet vented as per Clause 7.5.2.1.(1)(g). The kitchen sink is separately vented, and is not included in the calculation.

Continuous vent hydraulic load = lavatory + lavatory + 2-head shower + 2-head shower + flush tank WC = 12 fixture units

Step 5. Size the continuous vent.

From Table 7.5.8.3., a hydraulic load of 12 fixture units and a length of 4 metres will be adequately served by a 1 ¼ in. vent pipe. However, since the wet vent serves a water closet with a 3 in. trap, the continuous vent is required to be 1 ½ in.

Note that the branch drain downstream of the wet vent is sized based on the hydraulic load served. Branch hydraulic load = 2 lavatories, 2 2-head showers + kitchen sink + flush tank WC = 13.5 fixture units. The minimum size for this pipe is 3 inches based on Table 7.4.10.8. However 7.4.9.1.(1) prohibits a drainage pipe to drain to one of lesser size, so the branch drain downstream is required to be 4 in.

Exercise 4-19

Same as 4-18, except the kitchen sink is now wet venting the WC, so there are now 2 wet vents.

"Lavatory Wet Vent"

Wet vent hydraulic load = lavatory + lavatory + 2-head shower + 2-head shower = 8 fixture units.

From Table 7.5.8.1., the wet vent is not serving a water closet, so Column 2 is used. Since the hydraulic load is 8 fixture units, the wet vent pipe size is 3 in.

Continuous vent hydraulic load = lavatory + lavatory + 2-head shower + 2-head shower = 8 fixture units. The kitchen sink and water closet are separately vented.

From Table 7.5.8.3., a hydraulic load of 8 fixture units and a length of 4 metres will be adequately served by a 1 ¼ in. vent pipe.

"Kitchen Sink Wet Vent"

Wet vent hydraulic load = kitchen sink = 1.5 fixture units.

From Table 7.5.8.1., the wet vent is serving a water closet, so Column 3 is used. Since the hydraulic load is 1.5 fixture units, the wet vent pipe size is 2 in.

Continuous vent hydraulic load = kitchen sink + flush tank WC= 5.5 fixture units.

From Table 7.5.8.3., a hydraulic load of 5.5 fixture units and a length of 4 metres will be adequately served by a 1 ¼ in. vent pipe. However, since the wet vent serves a water closet with a 3 in. trap, the continuous vent is required to be 1 ½ in.

Exercise 4–20

Type of Vent	Min. Size	Max. Size	Size Based On				Table	Code References
			Trap Served	Hydraulic Load	Length	Size of Pipe Connected		
Individual Vent	N/A	N/A	Yes	No	No	No	T 7.5.7.1.	7.5.8.2.(1)
Dual Vent	N/A	N/A	Yes	No	No	No	T 7.5.7.1.	7.5.8.2.(1)
Wet Vent	N/A	N/A	No	Yes	No	No	T 7.5.8.1.	7.5.8.1.(1)
Branch Vent	N/A	N/A	No	Yes	Yes	No	T 7.5.8.3.	7.5.8.3.(1)
Continuous Vent	N/A	N/A	No	Yes	Yes	No	T 7.5.8.3.	7.5.8.3.(1)
Header	N/A	N/A	No	Yes	Yes	No	T 7.5.8.3.	7.5.8.3.(1)
Circuit Vent	N/A	N/A	No	Yes	Yes	No	T 7.5.8.3.	7.5.8.3.(1)
Stack Vent	N/A	N/A	No	Yes	Yes	No	T 7.5.8.4.	7.5.8.4.(1)
Vent Stack	N/A	N/A	No	Yes	Yes	No	T 7.5.8.4.	7.5.8.4.(1)
Offset Relief Vent	N/A	N/A	No	No	Yes	No	T 7.5.7.1.	7.5.7.4.(1)
Relief Vent	N/A	2	No	No	No	Yes	N/A	7.5.7.3.(1)
Additional Circuit Vent	N/A	2	No	No	No	Yes	T 7.5.7.1.	7.5.3.1.(10) & 7.5.7.3.(1)
Yoke Vent	N/A	N/A	No	No	No	Yes	N/A	7.5.7.5.(1)
Fresh Air Inlet	4	N/A	No	No	No	No	N/A	7.5.5.4.(1)
Grease Interceptor	1½	N/A	No	No	No	Yes	N/A	7.5.5.2.(6)
Oil Interceptor	1¼	N/A	No	No	No	Yes	N/A	7.5.5.2.(4)
Sanitary Sewage Sump/Tank	2	4	No	No	No	Yes	N/A	7.5.7.7.(2)
Dilution Tanks	2	4	No	No	No	Yes	N/A	7.5.7.7.(2)
Macerating Toilet Sump/Tank	1½	N/A	No	No	No	Yes	N/A	7.5.7.7.(3)

Exercise 4-21

1. K, L, & M soft 7.2.7.4.
2. Separation could occur during service and cause leakage of sewer gas and would not be detected. 7.3.3.4.
3. Supported every other floor, maximum 7.5 m. 7.3.4.4.
4. ABS/PVC 1 200 mm 7.3.4.5.

Exercise 4-22

1. If the fixture floods waste could enter the venting system and plug the system.
2. The vent pipe could be blocked by waste.
3. To reduce friction and to maximize the ability of air to enter the drainage system
4. Moisture sitting in a vent pipe mat reduce the cross-section and reduce venting effectiveness, also may lead to vent pipe deterioration.

Exercise 4-23

1. 7.5.6.5.(3) only when altering or adding to plumbing system in an existing building to be installed as per conditions (a) and (d) in 7.5.6.5.(3)

2. 7.5.6.5.(4) & (5)
    a) 1 m above 3.5 m in any other direction
    b) 2 m above, 3.5 m in any other direction
    c) to the ground?
    2 m above
    d) above a roof surface?
    150 mm above

3. 7.3.6.1.(2) when a chief building official requires it to be done.

Exercise 4-24

Vent Pipe	Vent Name	Developed length used to determine size, m	Hydraulic load used to determine size, fixture units	OBC Code Reference	Min. size, in.
A	Continuous Vent	A+C=13	5	7.5.7.1.	1½
B	Sump Vent	N/A	n/a	7.5.7.7.(2)	2
C	Branch Vent	A+C=13	5	7.5.7.7.(2) 7.5.7.2.(1)	2
D	Vent Stack	2+D+F+I+N +S+T=17	66	7.5.7.1. 7.5.7.2.	3
E	Individual and	N/A	n/a	7.5.7.1.	1¼

	Continuous Vent				
F	Vent Stack	Same as D=17	71	7.5.7.1. 7.5.7.2.	3
G	Continuous Vent	G=3	6	7.5.8.3.(5) 7.5.7.1.	1½
H	Dual and continuous Vent	N/A	n/a	7.5.7.1.	1¼
I	Vent Stack	Same as D=17	71	7.5.7.1. 7.5.7.2.	3
J	Circuit Vent	J+M=7	40	7.5.8.3.	1½
K	Additional Circuit Vent	N/A	n/a	7.5.7.1. 7.5.7.3.(1)	1½
L	Relief Vent	N/A	n/a	7.5.7.1. 7.5.7.3.(1)	1½
M	Branch Vent	J+M=17	40	7.5.7.1. 7.5.7.2.	1½
N	Vent Stack	Same as D=17	71	7.5.7.1. 7.5.7.2.	3
O	Stack Vent	O+Q+T=5	66	7.5.7.1. 7.5.8.4.	2
P	Circuit Vent	P=4	16	7.5.7.1. 7.5.8.3.(4)	1½
Q	Stack Vent	Same as O=5	66	7.5.7.1. 7.5.8.4.	2
R	Stack Vent	R+S+T=9	7.5	7.5.2.1.(1)(a)	3
S	Vent Header	A+C+F+I+ N+S+T=25	78.5	7.5.8.3.(3)	3
T	Vent Header	Same as T=25	78.5	7.5.8.3.(3)	3
U	Individual Vent	N/A	n/a	7.5.7.1.	1¼
V	Branch Vent	U+V+W=11	2	7.5.7.1. 7.5.7.2.	1¼
W	Branch Vent	Same as V=11	3	7.5.7.1. 7.5.7.2.	1¼
X	Stack Vent	X+Y=3	4	7.5.7.1. 7.5.8.4.	1¼
Y	Stack Vent	Same as X=3	4	7.5.7.1. 7.5.8.4.	1¼

MODULE 4 QUIZ

1. b) Div A 1.4.1.2.
2. c) 7.5.7.2.(2)
3. b) Table 7.5.7.1 1 ½ in. vent for equivalent 3 in trap.
4. d) 7.5.8.4.(2)
5. a) 7.5.3.1.(3) and (6)(b)
6. b) 7.5.4.5.(1)
7. b) 7.5.4.3.1.(1)
8. d) 7.5.4.2.
9. c) 7.5.8.2. and 7.5.5.2.
10. b) 7.5.7.1

MODULE 5

Exercise 5-1
Answers from Division A.

Exercise 5-2

1) A water service pipe, min ¾ inch 7.6.3.4.(1)

2) Tunnel, pipe corridor, common basement or parking garage, to be accessible for maintenance, 7.1.5.4.(2)

3) MOE, "Guidelines for the Design of Sanitary Sewage Systems, Guidelines for the Design of Storm Sewer Systems, Guidelines for the Design of Water Distribution Systems and Guidelines for Servicing in Areas Subject to Adverse Conditions. 7.1.5.5.(1)

4 4 inches 7.3.4.9.(1)

5) 2440 mm 7.3.5.7.(1))

6) Type K soft copper tube, ASTM B88,Table 7.2.11.2

7) Backflow caused by back-siphonage or back pressure, 7.6.2.4..

8) -With or without potable water
- system materials
-class of system hazard, Table 7.6.2.4.

9) hot water control on left, cold water control on right, 7.6.1.1.(2)

10) 7.6.1.6.(1) shut-off valves

11) 49 degrees Celsius 7.6.5.1.(1)

12) - where food prepared in a food processing plant
- above food-handling equipment
- above a non-pressurized potable water tank
-above a cover of a pressurized potable water tank

13) - a sink or lavatory
- fixture where potable system also discharges
- fixture used for preparation, handling, dispensing of food or drink or items for human consumption

Module 5 Quiz

1. c) Sentence 7.6.1.3.(5)
2. d)Article 7.6.1.5.
3. c) Sentence 7.1.5.3.(1)
4. d) Article 7.2.11.1.
5. a) Table 7.2.11.2.
6. d) Sentence 7.3.4.9.(4)
7. d) Sentence 7.3.5.7.(3)
8. c) Sentence 7.2.10.10.(2)
9. b) Sentence 7.6.4.2.(4)
10. d) Sentence 7.6.5.2.(2)

MODULE 6

Exercise 6-1
Titles from the Code.

Exercise 6-2

1. You can't!! 7.2.1.3.(1)

2. Cast iron drainage and vent pipe and fittings, CSA B70

3 ABS floor flanges, CAN/CSA-B181.1

4. Asbestos-cement drainage pipe and fittings (above ground),, CAN/CGSB-34.22 & CSA B127.1

5. PVC sewer pipe, CAN/CSA-B182.2

6. Copper pipe, ASTM B42

7. Mechanical couplings for DWV and sewer pipe, CAN/CSA-B602

8. Screwed cast iron water fittings, ANSI B16.4

9. Concrete pipe and fittings, CSA A257 SERIES

10. Aluminum DWV, CAN/CSA B281

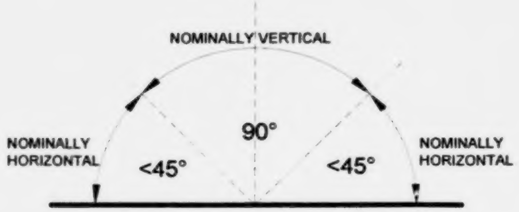
11. Ask for verification that the material is approved. If there is no verification, the material must be replaced with approved material.

Exercise 6-2

Nominally Horizontal: less than 45^0 with the horizontal

Nominally Vertical: not more than 45^0 with the vertical

Exercise 6-3
Definitions from Division A.

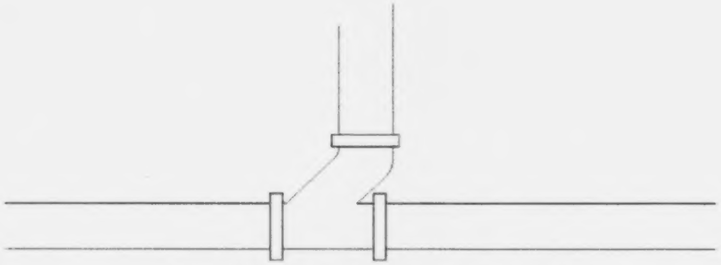


Exercise 6-4

1. A tee fitting cannot be used in a drainage system except to connect a vent pipe. 7.2.4.1.(1) The sharp edge of the weir can cause problems in a drainage system since solids can be "caught" at the sharp curve.

2. The same reason as above, also drainage might directed upstream into opposite drainage pipe.

Exercise 6-5



Y FITTING AND A 45º ELBOW

Exercise 6-6

1. 7.2.4.2.(2) Two urinals where no cleanout is provided. Also as per Table 7.2.4.5. if vertical run is less than 3 inches and/or branches are more than 2 in.

2. A ¼ bend of 4 in. size or less that has a centre-line radius that is less than the size of the pipe shall not be used to join two soil or waste pipes. A ¼ bend of 4 inch size or less shall not be used on a horizontal building drain, a branch of the building drain, or building sewer except to change direction from horizontal to vertical. Sentences 7.2.4.3.(1) & (2)

Exercise 6-7

1. Installing a double Wye fitting will not allow for proper slope on both drainage pipes and waste could go upstream into the other branch.

2. Install two separate Y fittings.

Exercise 6-8

Fitting	Vertical	Horizontal
TY-fitting	O.K.	only for venting
T-fitting	only for venting	only for venting
Cross fitting	only for venting	only for venting
Double Y	O.K.	NO
Double T-Y	O.K.	NO
double waste	O.K.	NO

Exercise 6-9

1. 7.2.4.2.(2) a single T-Y fitting may be used to connect a vent on a horizontal branch

Exercise 6-10

1. Closet carriers for WC's and urinals, back outlet closet carriers, expansion joints for drainage piping ... etc.

2. The remaining fixtures installed above two stack vented water closets shall be connected directly and independently to the stack above the centre-line of the connection of the two water closets and the upper most fixture is connected to the vertical portion of the stack.

Exercise 6-11

1. 7.4.6.4.(1) not permitted to be installed, 7.4.6.4.(2), permitted for single dwelling units, must meet appropriate CSA standard

Exercise 6-12

Examples from the class.

Exercise 6-13

1. Basement in dwelling unit 7.1.4.2, washroom containing urinals with auto flush devices., 3.7.4.13.

2. Concealed overflow not permitted for kitchen sinks 7.2.2.4., lavatories require centre outlet waste fitting if no overflow 7.2.2.6.(1)

3. Every fixture to be readily accessible for use, cleaning and maintenance 7.1.6.2.

4. Requirements are in 7.2.10.8., 7.6.4.2.

5. Requirements are in 7.2.10.9.

6. Requirements in 9.31.4.1 (dwelling units)., 9.31.1.1. sends to 3.7.4. for camps

7. 7.6.5.1. 49 degrees Celsius

8. 9.31.6.1. 49 to 60 degrees Celsius

9. 1) Shower receptor shall be leak proof. Sentence 7.2.2.3.(1)

   2) No more than 6 shower heads per drain. Sentence 7.2.2.3.(2)

   3) Floor shall be sloped so water does not drain from one head to another. Sentence 7.2.2.3.(3)

   4) Min 750mm between horizontal shower heads Sentence 7.2.2.3.(4)

Exercise 6-14

1. (b) 9.5 L/Min, Table 7.6.4.1.

2. (c) 3.8 L, Table 7.6.4.2.B

Module 6 Quiz

1 a) 7.2.1.3.
2 b) (Div A definition)
3. b) 7.2.4.2.
4. a) 7.2.4.5.
5. a) 7.2.4.2.(2)
6. a) 7.1.4.2(1)
7. c) 7.2.2.5.(1)
8. d) 7.2.10.1.(1)
9. b) 9.31.6.1.
10. d) 7.4.6.4.(2)

MODULE 7

Exercise 7-1

1. Except for suites of residential occupancy, a grease interceptor must be provided anywhere that food is cooked, processed or prepared & as close to the fixture as possible. Sentences 7.4.4.3.(1)&(7)

2. Water and grease do not mix and the grease floats on top of the water.

3. 7.2.3.2.(1) shall be designed to be readily cleaned & 7.2.3.2.(2) does not become air bound

4. Garbage grinders, potato peelers and similar equipment. Will cause blockage at the inlet of the interceptor. Sentence 7.4.3.3.(1)

5. Min 1 ½ in. vent pipe at outlet pipe, a vent pipe within 1500 mm of the inlet to the grease interceptor complete with a cleanout Sentences 7.5.5.2.(6)&(7)

6. Cleanout immediately downstream of an interceptor, at vent pipe max 1500 mm upstream of an interceptor Sentences 7.4.7.1.(8), 7.5.5.2.(7)

7. By removing the grease, the maintenance cost for private and public sewers are reduced

8. Sluggish flow, complete blockage, inconvenience interference with municipal sewage systems

Exercise 7-2

1. Service stations, repair shops and garages, any establishment where motor vehicles are repaired, lubricated or maintained. Where establishments use oily or flammable liquids or the waste contains these. Exceptions are drain in hydraulic elevator pit, or motor vehicle parking areas or car wash. Sentence 7.4.4.3.(2)

2. Ask for verification from owner/plumber or person responsible for the installation such as the engineer.

3. Yes. Sentence 7.4.7.1.(8). Cleanouts are required downstream of every interceptor. There are no different requirements for manufactured vs. built in place interceptors, both require cleanouts.

4. Two-3" vents. One at each end that extend independently to open air and at elevations differing by at least 300 mm. They shall terminate at least 2 m above grade. Do not connect to each other. Adjacent compartments shall be connected to each other by a vent. Sentences 7.5.5.2.

5. Not less than one size smaller than the largest connected drainage pipe, not less than 1 ¼ in. Sentence 7.5.5.2.(4)

6. To create air flow and remove explosive gases.

7. Install adjacent compartment vents. Install vent on inlet end of interceptor. Install cleanout.

Exercise 7-3

1. A temperature relief valve shall be installed within the top 150 mm of the tank, Clause 7.6.1.12.(2)(a)

2. When combined temperature and relief valves are installed, they must comply with Sentences 7.6.1.12.(1) & (2). As per Sentence 7.6.1.12.(3)

3. 1100kPa (160 PSI) or 1/2 the maximum test pressure sustained by the tank whichever is the lesser. Sentence 7.6.1.12.(1)

4. 99°C (210°F) Clause 7.6.1.12.(2) (b)

5. Every pressure vessel requires pressure relief valve 7.6.1.12.(1). Every storage-type service water heater requires temperature relief valve 7.6.1.12.(2)
Every indirect service water heater requires relief and temperature valves 7.6.1.12(4)

Exercise 7-4

7.6.1.3. to 7.6.1.10.)

Location	Type of Valve Required	Valve Location	Code Reference
Water service pipe	Building control valve	Entry to building	7.6.1.3.(1)
Gravity water tank	Shut-off valve	Piping close to the tank	7.6.1.3.(4)
Risers (except in single family dwellings	Shut-off valve	At source of supply	7.6.1.4.(1)

Water closets	Shut-off valve	Water supply pipe	7.6.1.5.(1)
Suites in a building of residential occupancy	Shut-off valve	Water supply in every suite so that supply to remainder of building is not interrupted	7.6.1.6.(1)
Each fixture in a washroom for public use	Shut-off valve ("valve" in Code)	Water supply to each fixture, in accessible location	7.6.1.7.(1)
Tanks	Shut-off valve	Water supply pipe, close to tank, pressure vessel, plumbing appliance or water using device	7.6.1.8.(1)
Plastic water service pipe suitable for cold water use only	Check valve	Building end of water service pipe	7.6.1.10.(1)

Exercise 7-5

Table 7.6.2.4.

1. Only for minor hazard residential partial flow-through systems

2. All systems except severe hazard systems

MODULE 7 QUIZ

1. (c) water does not mix with oil or grease
2. (b) in a repair garage, 7.4.4.3.(2)(a)
3. (b) downstream of an interceptor, 7.4.7.1.(8)
4. (d) both (a) and (b) 7.6.1.12.
5. (a) 100°F
6. (c) at least be equal in size the outlet of the valve, 7.6.1.12.(5)
7. (d) not permitted, 7.6.1.12.(7)
8. (b) 6 shower heads, 7.2.2.3.
9. (b) not be directly connected to a potable water supply unless it is isolated from the potable water supply by means of a back flow preventer
10. (c) to the requirements of a manufactured interceptor, 7.4.4.3.(6)

MODULE 8

Exercise 8-1

Note: Most mistakes in these calculations will occur if the participant forgets to split the occupant load 50/50 for males and females. Note: Lavatory requirements are in 3.7.4.2.(5)Staff require 1 WC and 1 lavatory each sex. Public requires 1 WC and 1 lavatory, and can use same washrooms as staff because accessible to public. Table 3.7.4.8., Sentence 3.7.4.8.(2)

2. 1 WC and 1 lavatory, Sentence 3.7.4.9.(2. Also 1 WC permitted under Sentence 3.7.4.2.(8)
3. 2 WC, 1 lavatory per sex for patrons, 1 WC 1 lavatory per sex for employees. Table 3.7.4.3.D., Table 3.7.4.3.F.
4. Washroom occupant load is based on 14 m2 person, 72 persons washroom occupant load, 36 persons each sex, 3 WC, 2 lavatories per sex. Sentence 3.7.4.2.(1), Table 3.7.4.7.
5. Note that Table 3.7.4.3.I. includes lavatories. In both age categories 1 WC and 1 lavatory can serve 10 children, therefore 5 WC and 5 lavatories are required. Table 3.7.4.3.I.
6. 600 persons each sex. Males = 6 + 1 = 7 WC and 4 lavatories. Females = 12 + 1 + 1= 14 WC, 7 lavatories. Table 3.7.4.3.A.

7. Floor drain, 3.7.4.13. Note: A flushometer, whether manual or electronic, is not considered an "automatic flushing device". An automatic device does not require an action by the user.

8. 3.7.6.4.(1) a separate lavatory for employees to wash hands

Exercise 8-2

1. All buildings, except: houses, duplexes, triplexes, townhouses, row houses, boarding houses and rooming houses with fewer than 8 boarders, F-1 major occupancy buildings, building not intended to be occupied full time. Sentence 3.8.1.1.(1)
2. Yes, because they are more than 45 metres away. Sentences 3.8.2.3.(2) & (3).

3. 500 mm x 1500 mm, toilet centreline 460-480 mm from wall on one side. Clauses 3.8.3.8.(1)(a) and (c).

4. Seat 400 – 460 mm from floor, accessible controls or automatic controls, back support if no seat lid or tank, no spring-activated seat. Clauses 3.8.3.9.(1)(a) to (d).

5. 760 mm wide, 735 mm high at front edge, 685 mm high to 205 mm back from front edge, 230 mm high 280 – 430 mm back from front edge. Clause 3.8.3.11.(1)(c).

6. Be insulated where they present a burn hazard, or have water temperature limited to maximum 43°C, Clause 3.8.3.11.(1)(d)

Exercise 8-3

1. FSR max 25, SDC max 50, Article 3.1.5.16.

2. FSR max 150, SDC max 300 for plumbing fixtures. Article 3.1.5.17. sends Code user to Subsection 3.1.13., Sentence 3.1.13.7.(4).

3. FT rating same as firewall, Sentence 3.1.9.1.(2)

4. A firestop system with an F rating the same as the fire separation, tested with a 50 Pa pressure differential. Sentence, 3.1.9.4.(4)

5. No, prohibited by Sentences 3.1.9.4(4) and (6)

Exercise 8-4

Summary of Types of Pools and Spas Regulated by the OBC
(Division A, Article 1.4.1.2. and Division B Subsection 3.11.)

Type of Pool	Brief Description	Code Reference
Public Pool	An artificial body of water used for sports or recreation, does not include pools serving less than 6 residences	Div. A, Article 1.4.1.2.
Class A	A public pool for the general public, generally at an institution, facility or recreational camp	Div. B, Sentence 3.11.2.1.(2)
Class B	A public pool generally operated in conjunction with residential or care uses	Div. B, Sentence 3.11.2.1.(3)
Modified Pool	Public pool that has a basin shaped floor sloping in from outside rim	Div. A, Article 1.4.1.2.
Wave Action Pool	Public pool with equipment to induce wave motion in water	Div. A, Article 1.4.1.2.
Public Spa	A hydro-massage pool that is not emptied after each use, does not include spas serving less than 6 residences	Div. A, Article 1.4.1.2.

Exercise 8-5

1. 0.45 m/s, 3.11.8.1.(17)

2. Yellow for chlorine and green for potable water. 3.11.8.1.(10) and (11),

3. Air gaps or other devices to prevent contamination of the potable water supply 3.11.8.1.(3)

4. Minimum 2 outlets separated by 1200 mm, clearly and permanently marked with 50 mm wide band of contrasting colour. 3.11.8.1.(15) & (18)

5. 40°C. Sentence 3.12.4.1.(17)

6. Yes, as per Article 3.1.5.22.

7. Minimum 140 kPa, 3.11.9.1.(7). Maximum 40°C. Sentence 3.11.9.1.(8)

8. Air gaps or other devices to prevent water in the sewer system from flowing back into the pool or its recirculation system. Sentence 3.11.8.1.(3)

MODULE 8 QUIZ

1. (a) 3.7.4.8.(4)
2. (c) 3.7.4.2.(3)(b)
3. (d) Table 3.7.4.9.
4. (b) 3.7.4.18.
5. (d) not regulated by the Building Code, 3.7.4.16. refers to 7.6.5., offices are addressed
6. (a) 3.7.6.4.(1)
7. (c) 3.1.5.16.(1)
8. (c) 3.6.4.3.(1)
9. (a) 3.1.9.4.(4)
10. (b) 3.12.4.1.(11)

APPENDICES

WATER PROPERTIES

PLUMBING – ALL BUILDINGS - 2007

OBJECTIVES

By the end of this Module the participants will be able to:

- explain the difference between potable and non-potable water
- identify the composition and states of water
- examine the behaviour and states of water under various conditions
- explain how to calculate the amount of energy required to raise water temperature using British Thermal Units (BTU)

INTRODUCTION

This Appendix material has been developed to give you information about the properties of water and its behaviour under various conditions.

Consider the following fact: Water is the single most important nutrient for sustaining life. Of all the basic necessary nutrients, perhaps water is the most underrated of all, yet some of us know very little about it. Therefore it is important that we know the value of water.

WATER QUALITY

The value of a safe water supply cannot be overestimated. Diseases such as cholera, typhoid, dysentery, and gastroenteritis can be transmitted through the water supply by bacteria. Although certain bacteria are actually beneficial to humans, those classified as **pathogens** are considered harmful. A Pathogen is "a micro-organism capable of causing disease. Chlorination of the water supply is the most widely used means in killing bacteria.

More recently, concerns about the presence of inorganic substances in the water supply has increased. The amount of heavy metals such as lead, mercury, cadmium, copper and chromium has increased as result of industrialization. While some of these metals are desirable in the human diet in small quantities, others such as lead and mercury accumulate in the body and causes serious illness after years of exposure.

Other inorganic substances such as nitrates, arsenic, sulfates, sodium, magnesium, fluoride, selenium, and calcium may also be found in undesirable quantities. Some of these inorganic substances are desirable in very small quantities, however, when the desired limits are exceeded, harmful effects may result.

Organic chemicals such as benzene, carbon tetrachloride, chloroform, PCB, toluene, and vinyl chloride have all been discovered as contaminants in some water supplies. All of these substances are known to be harmful to humans if ingested in large enough quantities.

Gases such as methane and hydrogen sulfide may also be present. Both are flammable. Methane smells like sewer gases while hydrogen sulfide smells like rotten eggs. Radiation, primarily from radon gas, may also enter the ground water supply. Since radiation is linked to cancer, concern about its existence in the water supplies has been raised.45, "Control of Gaseous Indoor Air Contaminants"

Other materials or problems commonly found in water samples include:

- Iron oxide

- Turbidity (lack of clarity or purity)

- High or low pH level (i.e. acid level)

Iron oxide produces a reddish stain on fixtures. Calcium and magnesium make water "hard" so that soaps do not work as effectively. Water that is not clear is said to be turbid. High pH water is alkaline and produces a bad taste. Low ph is acidic and more corrosive than neutral pH water.

While an inspector is not expected to be an expert in water testing or treatment, knowing some of this information may prove to be helpful in the event that someone asks "why is my water ....?"

Many people are installing water treatment equipment in buildings served by municipal water utility companies. Water softeners have been in use for many years. Filters and other water treatment devices are becoming increasingly popular as the concern of the quality of the public water supply increases. Therefore, it is necessary for the inspector to have a general understanding of the types of contamination found in water and the types of devices used to solve these problems.

Pure water is colourless, tasteless and odourless.

First, it should be understood that "pure water" does not really exist. All water contains gases and minerals. In fact, trace minerals make water taste "good".

In addition to natural sources of contamination, industrial processes, combustion gases, and agricultural fertilizers are major sources of water pollutants. For water to be **potable** (safe for human consumption), these pollutants must either be removed or reduced to safe levels. There are individuals who are particularly susceptible to some contaminants and, therefore, may need even higher quality water. Also, some industrial processes, such as the production of pharmaceuticals, require extremely high-quality water.

In addition, it is important to note that domestic animals, such as livestock, also require potable water. Permitting livestock to drink polluted water not only causes damage to their health, but some pollutants can accumulate in the animals and become a problem for the people who consume milk, poultry, and meat products.

Definitions

- Chlorination- to treat with chlorine
- Pasteurization- partial sterilization with heat
- Ultraviolet Radiation- killing bacteria with ultraviolet light
- Reverse Osmosis- pumping water through a membrane at pressure between 200 & 400 P.S.I. The membrane is so fine that only water and certain organic chemical can pass through.

The following chart identifies the common types of water contaminants and suggests one or more treatment processes that may be used to remove or reduce the quantity of the contaminant.

CONTAMINANT	POSSIBLE TREATMENT(S)
Bacteria (pathogenic) Cholera, typhoid, dysentary, giardiasis, etc.	Chlorination, pasteurization, and ultraviolet radiation Reverse osmosis
Protozoa parasites Giardia lamblia, etc.	Chlorination or superchlorination plus filtration Reverse osmosis
Viruses Polio, gastroenteritis, hepatitis, meningitis, etc.	Chlorination or superchlorination plus filtration Reverse osmosis
Inorganic chemicals Arsenic, asbestos, barium, cadmium, chromium, copper, lead, mercury, nitrates, selenium, sulfates, fluoride, nickel, sodium, zinc, etc.	Reverse osmosis or distillation
Organic chemicals Benzene, carbon tetrachloride, chloroform, PCB's, pesticides, toluene, vinyl chloride, etc.	Activated charcoal filter

Gases	
Radon	Activated charcoal filter, aeration
Methane	Activated charcoal filter, aeration
Sulphur dioxide	Activated charcoal filter, oxidizing filter, or chlorination plus filter
Other water problems	
Iron oxide	Chlorination plus filter
Calcium	Water softener, Reverse osmosis
Magnesium	Water softener, Reverse osmosis
Turbidity	Filter, Reverse osmosis
pH	
Acid pH < 7	Calcite filter, add soda ash or caustic soda
Alkaline pH > 7	Add sulfuric acid in extreme cases
Sediment	Sediment filter

Exercise 1-1

Read the definition of potable in Division B Part 1 of The Ontario Building Code. Then in your own words write down what potable water means to you.

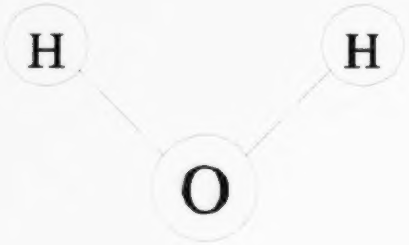
Exercise 1-2

Discuss with your group what you would consider non-potable water and why.

COMPOSITION AND PHYSICAL ATTRIBUTES OF WATER

Take a couple of minutes to read the following and complete Exercise 1-3. Do not go past the stop sign.

The composition of water is relatively simple. It is a combination of the elements hydrogen and oxygen. Two molecules hydrogen to one molecule oxygen produces a liquid called water. The chemical symbol is H_20.



M1D1

As water is heated or cooled it changes states.

Exercise 1-3

List the three different states you can find water in.

Water can be found in three states - solid, liquid and gas. The **density** of water is relative to the distance of one particle of H_20 to another particle of H_20 and is **1 kg/l at 4^0C at sea level.**

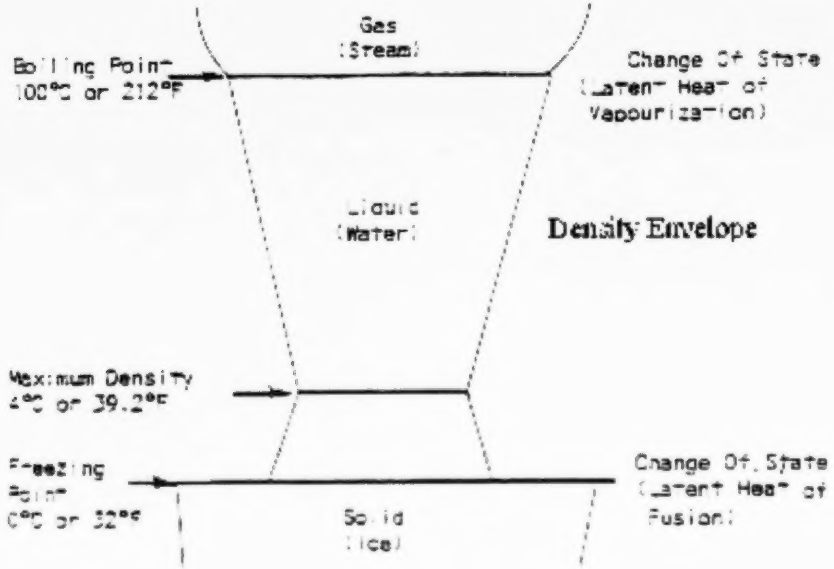
Heat plays an important role in the change from one state to another. As heat is added or taken away, the particles either separate or become closer together.

At 14.7 P.S.I.A (Sea level) (P.S.I.A. = pounds per square inch atmospheric)
Freezing point of water - 0°C or 32°F
Maximum density of water - 4^0C or 39.2^0F
Boiling point of water - 100^0C or 212^0F

Changes of Sate
& Associated Temps.

Actual State

Change of Sate
Energy Exchange Points


Gas
(Steam)
Boiling Point
100°C or 212°F
Change Of State
(Latent Heat of
Vapourization)
Liquid
(Water)
Density Envelope
Maximum Density
4°C or 39.2°F
Freezing
Point
0°C or 32°F
Change Of State
(Latent Heat of
Fusion)
Solid
(ice)

M1D2

Remind the class why these changing states are important to them. The O.B.C. requires relief valves on hot water tanks and also to protect pipes from freezing because of these changes in state and the resulting stresses due to these state changes

TEMPERATURE EFFECTS ON BOILING POINTS

We see that water reaches its maximum density at 4°C or 39.2°F. Water will continue to expand above and below this point. When the temperature is increased to 100°C or 212°F, a change of state takes place and we now have a gas (steam). When the temperature is decreased to 0°C or 32°F, a change from a liquid to a solid (ice) occurs. This is why ice floats, the water has expanded and therefore the density has decreased.

Atmospheric pressure affects the boiling point of water as shown in the following table.

When the atmospheric pressure is lowered, the boiling point of water is lowered. The reverse is also true.

TABLE 1

Atmospheric P.S.I.A.	Boiling Point
0	212°F
15	250°F
30	274°F
50	297°F
75	320°F
100	338°F
125	353°F
150	366°F

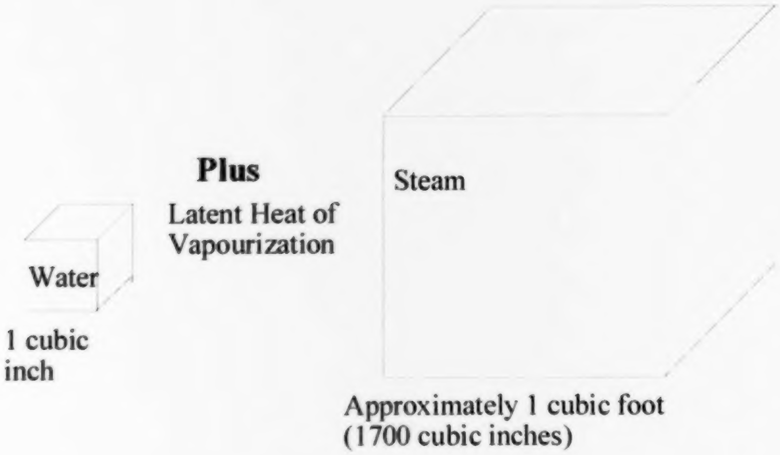
NOTE:

If the atmospheric pressure is less than 14.7 P.S.I., water will boil at a lower temperature. If water is confined in a vacuum, it can boil at as low as 60°F.

VOLUMETRIC CHANGE OF WATER

If we take one cubic inch of water and convert it to steam we would have approximately 1700 cubic inches of steam. The process of converting liquid water to a gas is called a **change of state**. The amount of energy required to do this is called the "**Latent Heat of Vaporization**".

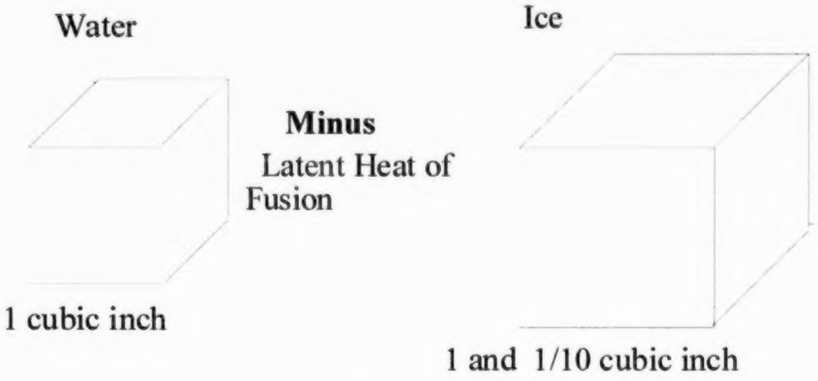
Because of this expansion ratio and the hazards of explosions, the OBC requires relief valves on all hot water tanks.


Plus
Latent Heat of Vapourization
Steam
Water
1 cubic inch
Approximately 1 cubic foot (1700 cubic inches)

Note: diagrams are not to scale.

M1D4

If we take one cubic inch of water and convert it to ice, we would have approximately 1 and 1/10 cubic inch of ice. The amount of energy required to do this is called "Latent Heat of Fusion".



Note: diagrams are not to scale.

M1D5

It is this expansion that leads to pipes rupturing when exposed to freezing conditions. This is why OBC requires piping to be protected from freezing.

The reverse is also true. Steam gives up the amount of energy (Latent Heat of Vaporization) to become liquid water while the input of energy (Latent Heat of Fusion) would change the state of ice to liquid water.

Exercise 1-4

1. If water is at atmospheric conditions of 14.7 P.S.I.A. (sea level), give the correct temperatures for the:

a) freezing point *0°C* or *32°F*

b) maximum density *4°C* or *39.2°F*

c) boiling point *100°C* or *212°F*

2. The change of state of water from a solid to a liquid takes place at a temperature of 0°C or 32°F.

3. The change of state of water from a liquid to a gas takes place at a temperature of *100°C* or *212°F*.

4. When water is converted to steam its expansion factor is approximately *1700*.

5. The denisty of ice in relation to liquid water is *0.9*.

6. The heat required in the change from water to steam is called the *Latent Heat of Vapourization*

7. The heat released in the change from steam to water is called the Latent Heat of Vapourization.

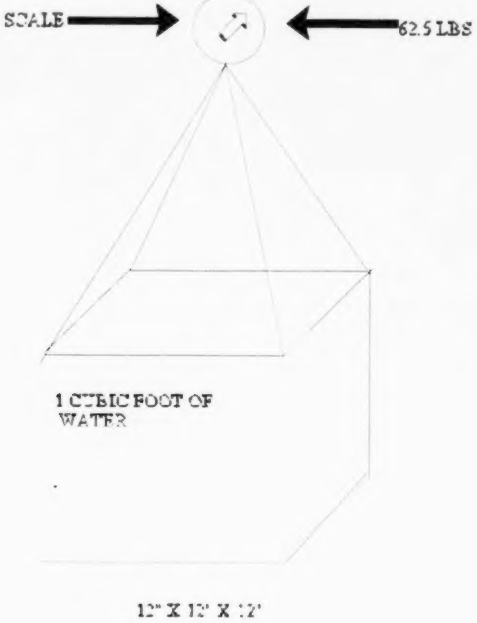
8. The heat required in the change from ice to water is called the *Latent Heat of Fusion*

9. Water subjected to a gauge pressure of 50 P.S.I. will boil at a temperature of *297°F*.

WEIGHTS AND MEASUREMENTS OF WATER

Review the chart below. These are the widely used and accepted values for drinking water.

1 cubic foot of water = 62.5 pounds
1 imperial gallon water = 10 pounds
1 cubic foot of water = 6.25 Imperial gallons


SCALE
62.5 LBS
1 CUBIC FOOT OF WATER
12" X 12" X 12"

M1D6

Take a few minutes to complete Exercise 5 and put your answers up on the flip chart.

Exercise 1-5

1) How much additional weight would a tank filled with water measuring 3 feet x 3 feet x 3 feet weigh?

   3 x 3 x 3 = 27 cubic feet
   27 x 62.5 = 1687.5
   1687.5 pounds

2) How many Imperial gallons are in the 3' x 3' x 3' cube?

   3 x 3 x 3 = 27 cubic feet *27 x 6.25 = 168.75*

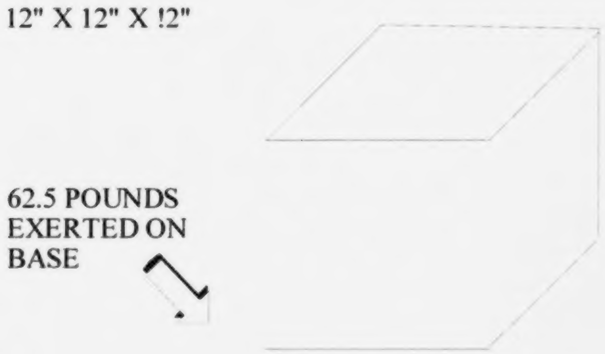
   168.75 Imperial Gallons

DETERMINING FACTORS OF WATER PRESSURE

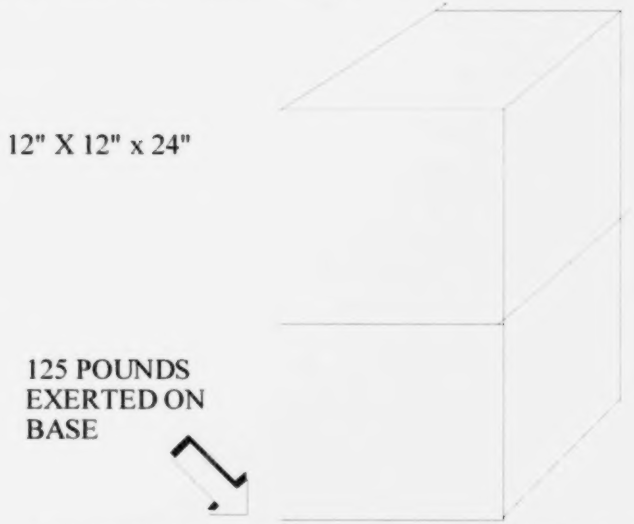
FACT:
For all practical purposes water is incompressible

WATER PRESSURE

As stated earlier a cubic foot of water weighs 62.5 pounds and exerts 62.5 pounds of pressure per square foot on the bottom of its container. If a tank 1 foot wide, 1 foot long, and 2 feet high is filled with water the pressure on the bottom of the tank is 62.5 x 2 = 125 pounds per square foot.


12" X 12" X !2"
62.5 POUNDS EXERTED ON BASE

A CUBIC FOOT OF WATER WEIGHS 62.5 POUNDS AND EXERTS A PRESSURE OF 62.5 POUNDS PER SQUARE FOOT ON THE BASE OF ITS CONTAINER


12" X 12" x 24"
125 POUNDS EXERTED ON BASE

AS THE DEPTH OF THE WATER INCREASES, THE PRESSURE EXERTED ON THE BOTTOM OF A TANK INCREASES

M1D7

The general formula for finding the pressure exerted by water of varying depths is as follows:

$$P = 62.5 \times D$$

Where P = **Pressure** per square foot
D = **Depth** of the water in feet

Exercise 1-6

1) What is the pressure per square foot on the bottom of a tank filled to a depth of 12.5 feet?

$P = 62.5 \times D$
$P = 62.5 \times 12.5$
$P = 781.25$ pounds per square foot

Note that the pressure was computed in pounds per square foot (PSF). It is common practice to compute pressure in pounds per square inch (PSI). Since there are 144 square inches of surface in a square foot, the formula is modified as shown to compute pressure in pounds per square inch.

$$P = \frac{62.5}{144} \times D = 0.434D$$

Where P = **pressure** per square inch
D = **depth** of water in feet

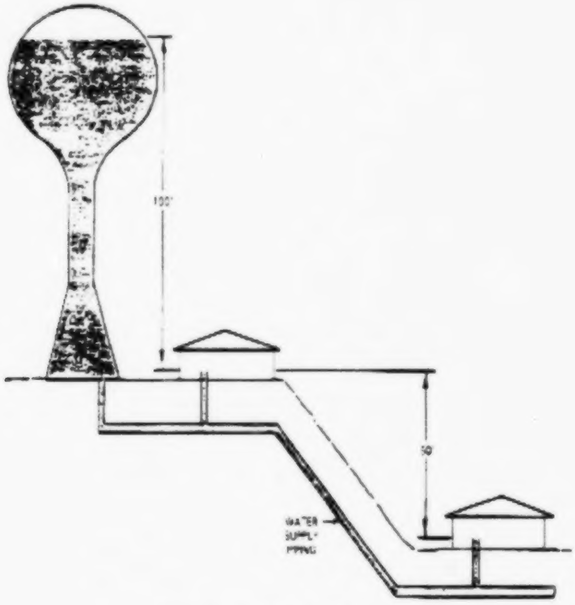
2) What is the pressure in pounds per square inch at the bottom of a tank filled to a depth of 20.75 feet?

$P = 62.5 \div 144 \times D$
$P = 62.5 \div 144 \times 20.75$
$P = 9$ pounds per square inch

This same basic principal accounts for the increase in water pressure after installing a water tower as part of a municipal water supply system. If water is stored in a tower to a height of 100 feet, the water pressure at the base would be computed the same way.

3) What would the pressure be in P.S.I. at the base of a water tower if the water level is 100 feet above the point the pressure is being measured?

$P = 62.5 \div 144 \times D$
$P = 62.5 \div 144 \times 100$
$P = 43.4\ PSI$



Water pressure increases as the depth of the water increases.

M1D8

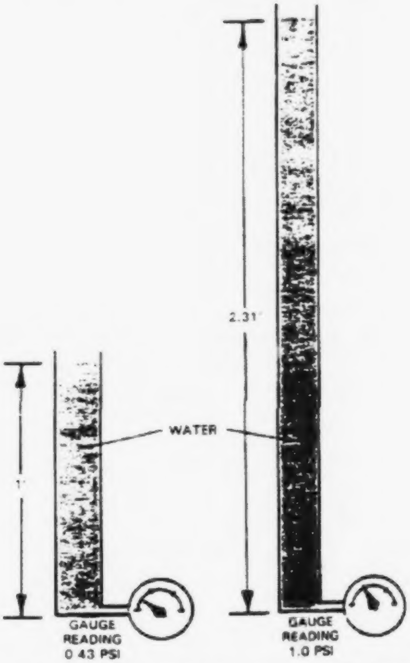
4) What would the water pressure be in P.S.I. if the house was 150 feet below the level of the water in the tower?

$P = 62.5 \div 144 \times D$
$P = 62.5 \div 144 \times 150$
$P = 65.1\ PSI$

PRESSURE HEAD

Pressure head is the pressure available at any point in the water system. It is measured by the height of a column of water above the point where the measurement is taken. In the previous example, the pressure head at the base of the water tower is 100 feet.

As shown earlier, we know that a column of water 1 foot high produces a pressure of 0.434 P.S.I. Another way of thinking about the relationship between pressure head and pressure measured in pounds per square inch is that **a column of water 2.31 feet tall will produce a pressure of 1 P.S.I.**



Relationship of head to pressure can be shown with columns of water and pressure gauges.

M1D9

For some calculations, pressure head or head loss is used rather than pressure or pressure loss. It is important that these two concepts be understood. Otherwise, calculations dependent on these measurements cannot be made correctly.

In some cases, it will be necessary to convert pressure head to pounds per square inch or to convert pounds per square inch to pressure head.
Two rules can be used to determine unit pressure.

Rule 1 - when the head of water in feet is known
P.S.I. = head in feet x .434
Rule 1 is based on the fact that 1 foot of water produces a pressure of 0.434 P.S.I

Rule 2 - when the P.S.I. of water is known
Head in feet = P.S.I. x 2.31'
Rule 2 is based on the fact that 2.31 feet of head produces 1 P.S.I. pressure.

Read through the following examples and do the following exercises down to the stop sign.

Example 1

Find the pressure in P.S.I. of water when the head is 45 feet

Formula P.S.I = head in feet x .434
Solution = 45' x .434
= 19.53 P.S.I.

Example 2

Find the pressure in P.S.I. of water when the head is 93 feet

Formula P.S.I. = head in feet x .434
Solution = 93' x .434
= 40.4 P.S.I.

Example 3

Find the head in feet of water when the pressure is 85 P.S.I.

Formula Head = P.S.I. x 2.31
Solution = 85 x 2.31
= 196.35

Exercise 1-7

1) Calculate the pressure in P.S.I. readings when the head in feet is given

(a) Head 50 ft. = 21.7 PSI
(b) Head 68.5 ft. = 29.7 PSI
(c) Head 76.25 ft. = 33.1 PSI

2) Calculate the head in feet for the given pressures

(a) 29 P.S.I. = 67 feet
(b) 45 " = 104 feet
(c) 63 " = 145.5 feet

TEMPERATURE EFFECTS ON WATER PRESSURE

Water pressure is also determined by temperature - i.e. water pressure in an open system will remain constant under atmospheric conditions (atmospheric pressure = 14.7 P.S.I.A)

Water in a closed system is adversely affected by temperature. Pressure will increase with heat.

Exercise 1-8

1) A plumber puts a 100 P.S.I. test on a water service system in the heat of the afternoon. With the cooling temperatures over night, the pressure gauge will indicate a loss of pressure. Explain why?

When air is cooled, it condenses therefore the pressure will drop.

FRICTION EFFECTS ON WATER PRESSURE AND FLOW RATES

It should also be known that friction will alter water pressure and flow rates.

There are two causes of friction within a plumbing system.

1. Water rubbing against the interior wall of the pipe
2. Particles of water striking one another

For instance water running through a large bore pipe, with smooth walls at low pressure generates a fairly small amount of friction. In turn a small diameter pipe with rough walls at higher pressure will create a greater amount of friction.

ENERGY CALCULATIONS

Read through the following information on B.T.U.s. and complete Exercises 1-9 and 1-10. Do not go pass the stop sign.

The **British Thermal Unit** (BTU) is a standard unit for measuring heat quantity and is defined as:

The amount of heat energy required to raise or lower one pound of water through one F^0.

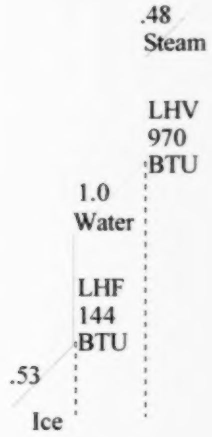
A BTU is a small quantity of heat, roughly the amount given off by a match.

Specific Heats of Materials

Specific heat of a material:

Is the ability of a substance to absorb or release heat.
The specific heat of a few substances are given below:

Substance	Specific Heat
Hydrogen	3.4
Liquid Ammonia	1.125
Water	1.0
Alcohol	0.602
Ammonia	0.52
Steam	0.48
Air	0.24
Ice	0.53



LHF= Latent Heat of Fusion
LHV= Latent Heat of Vaporization

Ice heats up to 32 degrees F. where it exists in both liquid & solid states. To change solid to liquid, LHF must be provided. This amount of heat changes the ice to water. Then the liquid heats up to 212 degree F. If the LHV is applied, liquid will convert steam. Once the liquid is gas, it will continue to rise in temperature with addition of more heat. The reverse is also valid except that heat must be released; that is, cooling of the material occurs.

Sensible Heat is heat that can be felt and measured (temperature change).

Latent Heat is the amount of heat required to change the state of a substance without changing its temperature.

The **Latent Heat of Fusion** for water (the energy required to change water to ice or ice to water) is 144 BTU's per pound.

The **Latent Heat of Vaporization** for water (the amount of heat energy required to change water to steam) is 970 BTU's per pound.

Heat Equation

BTU = Mass X temperature change X Specific heat
= $M (t1 - t2) sh$

Where: M = Mass
t1 - t2 = temperature difference
sh = specific heat
BTU = Heat quantity

Example:

Given: A quantity of heat is added to 1 pound of water in order to raise its temperature from 32 degrees to 212 degrees.

Find: The quantity of heat required in BTU's.

Solution: BTU's = M (t1 - t2) sh
= 1 (212 - 32) 1
= 1 x 180 x 1
= 180 BTU's

Therefore: The quantity of heat required to raise the temperature of one pound of water from 32 degrees to 212 degrees is 180 BTU's. Also 180 BTU's are liberated or given off when one pound of water at 212^{0}F is cooled to 32^{0}F.

Exercise 1-9

Determine the amount of BTU's required to raise 35 pounds of water from 35^{0}F - 198 F^{0}

$BTU's = M \times (t1 - t2) \times sh$
$= 35 \times (198 - 35) \times 1$
$= 35 \times 163 \times 1$
$= 5705\ BTU's$

Exercise 1-10

Determine the amount of BTU's required to raise the 10 pounds of water from 40° F to 60° F.

$BTU's = M \times (t1 \times t2) \times sh$
$= 10 \times (60 - 40) \times 1$
$= 10 \times 20 \times 1$
$= 200\ BTU's$

Where a change in state occurs, the latent heat must be added or removed from the sensible heat.

GENERAL FORMULA:

$BTU's = M(dt)(sh1) + M(LHF) + M(dt)(sh2) + M(LHV) + M(dt)(sh3)$

where:

M = mass
dt = change in temperature
sh1 = specific heat for solid
sh2 = specific heat for liquid
sh3 = specific heat for gas
LHF = Latent Heat of Fusion

LHV = Latent Heat of Vaporization

Example:

A quantity of heat is added to 10 pounds of ice at 14^{0}F to produce 10 pounds of water at 182^{0}F.

For change of states:
BTU'S = M X (Latent Heat) There is no temperature change.

Find: The quantity of heat required in BTU.s

Where: M = Mass
t1 - t2 = temperature difference
sh = Specific heat
LHF = Latent heat of fusion
(144 BTUs. per pound)
BTU = Heat quantity

Solution:

BTU.s ICE + (ICE+LIQUID) + LIQUID
=M (t1 - t2) sh + M (LHF) + M (t1-t2) sh
=10 (32-14) .53 + 10 (144) + 10 (182 - 32) 1
=(10 x 18 x .53) + (10 x 144) + (10 x 150 x 1)
=95.4 + 1,440 + 1,500
=3,035.4 BTUs.

Therefore the quantity of heat required to change 10 pounds of ice at 14^{0}F to 10 pounds of water at 182^{0}F is 3,035.4 BTUs. or 303.54 BTUs. per pound.

Exercise 1-11

Determine the BTU's required to raise 20 lbs. of ice at 10^{0}F to water at 200^{0}F.

20 (32-10) .53 + 20 (144) + 20 (200-32)
1(20 x 22 x .53) + (20 x 144) + (20 x 168 x 1)
233.2 + 2880 + 3360
6473.2 BTUs.

Read through the following example and complete Exercise 1-12.

To change water to steam the formula must include the **"Latent Heat of Vapourization"** (LHV).

Example:

A quantity of heat is added to 10 pounds of water at 92^{0}F to produce 10 pounds of steam at 222^{0}F.

Find the quantity of heat required in BTUs.

Where: M = Mass
t1 - t2 = Temperature difference
sh = Specific heat
LHV = Latent heat of vapourization
(970 B.T.U.s. per pound)
BTUs = Heat quantity

Solution:
B.T.U.s = M (t1 -t2) sh + M (LHV) + M (t1 -t2) sh
= 10 (212 - 92) 1 + 10 (970) + 10 (222- 212).48
= (10 x 120 x 1) + (9,700) + (10 x 10 x .48)
=1,200 + 9,700 + 48
=10,948 B.T.U.s.

Therefore the quantity of heat required to change 10 pounds of water at 92^{0}F to 10 pounds of steam at 222^{0}F is 10,948 B.T.U.s or 1,094.8 B.T.U.s per pound.

Exercise 1-12

Determine the BTU's required to raise 20 lbs. of water at 150^{0}F to steam at 217^{0}F.

20 (212 - 150) 1 + 20 (970) + 20 (217 - 212) .48
(20 x 62 x 1) + (20 x 970) + (20 x 5 x .48)
1240 + 19400 + 48
20688 B.T.U.s.

Water Properties Test

1. Water that has a smell like rotten eggs contains:

   (a) methane
   (b) high pH
   (c) low pH
   (d) hydrogen sulfide

2. One cubic foot of water weighs:

   (a) 52.6 pounds
   (b) 60.5 pounds
   (c) *62.5 pounds*
   (d) 65.2 pounds

3. The composition of water is:

   (a) 1 part hydrogen - 2 parts oxygen
   (b) 2 parts hydrogen - 2 parts oxygen
   (c) 1 Molecule hydrogen - 3 molecules oxygen
   (d) 2 Molecules hydrogen - 1 Molecule oxygen

4. Water reaches its maximum density at:

   (a) *4°C or 39.2°F*
   (b) 0°C or 32°F
   (c) 100°C or 212°F
   (d) when it changes to ice

5. The amount of heat required to change the state of a substance without changing its temperature is called:

   (a) sensible heat
   (b) latent heat of vaporization
   (c) latent heat
   (d) latent heat of fusion

6 One BTU is the amount of heat energy required to increase one pound of water:

(a) *1°F*
(b) 1°C
(c) 5°F
(d) 10°F

7. If a reddish stain appears on plumbing fixtures, it is likely that the water contains:

(a) hydrogen sulfide
(b) methane
(c) iron oxide
(d) magnesium

8. The amount of BTU's required to raise one pound of water 45°F is:

(a) 4.5 BTU's
(b) *45 BTU's*
(c) 450 BTU's
(d) 4500 BTU's

9. A column of water 23.1 feet high would produce a pressure at the bottom:

(a) 1 PSI
(b) 8 PSI
(c) *10 PSI*
(d) 20 PSI

10. When water is converted into steam the expansion ratio is:

(a) 1200 times
(b) 1300 times
(c) 1500 times
(d) *1700 times*

ANSWERS

Exercise #1

Read the definition of potable in The Ontario Building Code. Then in your own words write down what potable water means to you.
Water that is fit for human consumption - 1.1.3.2

Exercise #2

Discuss with your group what you would consider non-potable water and why.
Water containing high levels of bacteria, pathogen bacteria, heavy metals, gases, inorganic compounds, radioactive water and organic chemicals, radioactive water.

Exercise #3

List the three different states you can find water in.
Gas (steam)
Liquid (water)
Solid (ice)

Exercise #4

1. If water is at atmospheric conditions of 14.7 P.S.I.A. (sea level), give the correct temperatures for the:
    a) freezing point 00C or 320F
    b) maximum density 40C or 39.20F
    c) boiling point 1000C or 2120F

2. The change of state of water from a solid to a liquid takes place at a temperature of 00C or 320F.

3. The change of state of water from a liquid to a gas takes place at a temperature of 1000C or 2120F.

4. When water is converted to steam its expansion factor is approximately 1700.

5. The denisty of ice in relation to liquid water is 0.9 .

6. The heat required in the change from water to steam is called the Latent Heat of Vapourization
7. The heat released in the change from steam to water is called the Latent Heat of Vapourization.

8. The heat required in the change from ice to water is called the Latent Heat of Fusion
9. Water subjected to a gauge pressure of 50 P.S.I. will boil at a temperature of 2970F.

Exercise #5

1) How much additional weight would a tank filled with water measuring 3 feet x 3 feet x 3 feet weigh?
3 x 3 x 3 = 27 cubic feet
27 x 62.5 = 1687.5
1687.5 pounds

2) How many Imperial gallons are in the 3' x 3' x 3' cube?
3 x 3 x 3 = 27 cubic feet
27 x 6.25 = 168.75
168.75 Imperial Gallons

Exercise #6

1) What is the pressure per square foot on the bottom of a tank filled to a depth of 12.5 feet?
P = 62.5 x D
P = 62.5 x 12.5
P = 781.25 pounds per square foot

2) What is the pressure in pounds per square inch at the bottom of a tank filled to a depth of 20.75 feet?
P = 62.5 ÷ 144 x D
P = 62.5 ÷ 144 x 20.75
P = 9 pounds per square inch

3) What would the pressure be in P.S.I. at the base of a water tower if the water level is 100 feet above the point the pressure is being measured?
P = 62.5 ÷ 144 x D
P = 62.5 ÷ 144 x 100
P = 43.4 PSI

4) What would the water pressure be in P.S.I. if the house was 150 feet below the level of the water in the tower?

P = 62.5 ÷ 144 x D
P = 62.5 ÷ 144 x 150
P = 65.1 PSI

Exercise #7

1) Calculate the pressure in P.S.I. readings when the head in feet is given
(a) Head 50 ft. = 21.7 PSI
(b) Head 68.5 ft. = 29.7 PSI
(c) Head 76.25 ft. = 33.1 PSI

2) Calculate the head in feet for the given pressures
(a) 29 P.S.I. = 67 feet
(b) 45 " = 104 feet
(c) 63 " = 145.5 feet

Exercise #8

1) A plumber puts a 100 P.S.I. test on a water service system in the heat of the afternoon. With the cooling temperatures over night, the pressure gauge will indicate a loss of pressure. Explain why?
When air is cooled, it condenses therefore the pressure will drop.

Exercise #9

Determine the amount of BTU's required to raise 35 pounds of water from 350F - 198 F0

BTU's = M x (t1 - t2) x sh
= 35 x (198 - 35) x 1
= 35 x 163 x 1
= 5705 BTU's

Exercise # 10

Determine the amount of BTU's required to raise the 10 pounds of water from 40o F to 60o F.

BTU's = M x (t1 x t2) x sh
= 10 x (60 - 40) x 1
= 10 x 20 x 1
= 200 BTU's

Exercise #11

Determine the BTU's required to raise 20 lbs. of ice at 100F to water at 2000F.
20 (32-10) .53 + 20 (144) + 20 (200-32) 1
(20 x 22 x .53) + (20 x 144) + (20 x 168 x 1)
233.2 + 2880 + 3360
6473.2 BTUs.

Exercise #12

Determine the BTU's required to raise 20 lbs. of water at 1500F to steam at 2170F.
20 (212 - 150) 1 + 20 (970) + 20 (217 - 212) .48
(20 x 62 x 1) + (20 x 970) + (20 x 5 x .48)
1240 + 19400 + 48
20688 B.T.U.s

Water Properties Test

1. Water that has a smell like rotten eggs contains:
   (d) hydrogen sulfide

2. One cubic foot of water weighs:
   (c) 62.5 pounds

3. The composition of water is:
   (d) 2 Molecules hydrogen - 1 Molecule oxygen

4. Water reaches its maximum density at:
   (a) 40C or 39.20F

5. The amount of heat required to change the state of a substance without changing its temperature is called:
   (c) latent heat

6 One BTU is the amount of heat energy required to increase one pound of water:
   (a) 10F

7. If a reddish stain appears on plumbing fixtures, it is likely that the water contains:
   (c) iron oxide

8. The amount of BTU's required to raise one pound of water 450F is:
   (b) 45 BTU's
9. A column of water 23.1 feet high would produce a pressure at the bottom:
   (c) 10 PSI

10. When water is converted into steam the expansion ratio is:
   (d) 1700 times